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ABSTRACT

This curriculum guide consists of nine modules on lighting, one of the three divisions of the standardized trade electricity curriculum in high schools in New York City. The nine modules cover the following subjects: armored cable, rigid conduit, electrical metallic tubing, services and meters, fluorescent lighting, metal molding, wiremold, Romex, and low-voltage remote control. Each unit is comprised of performance objectives and tasks to meet the performance objectives, keyed to teaching content. Teaching content is offered in a three-column arrangement consisting of tasks, development of technical skills, and development of related information (reinforcement of basic skills). Some of the units are illustrated with line drawings. A section that provides suggestions for integrating basic skills instruction with the technical content also is offered. Appendixes to the guide contain a bibliography, a sample lesson plan, and a blank student evaluation report. (KC)

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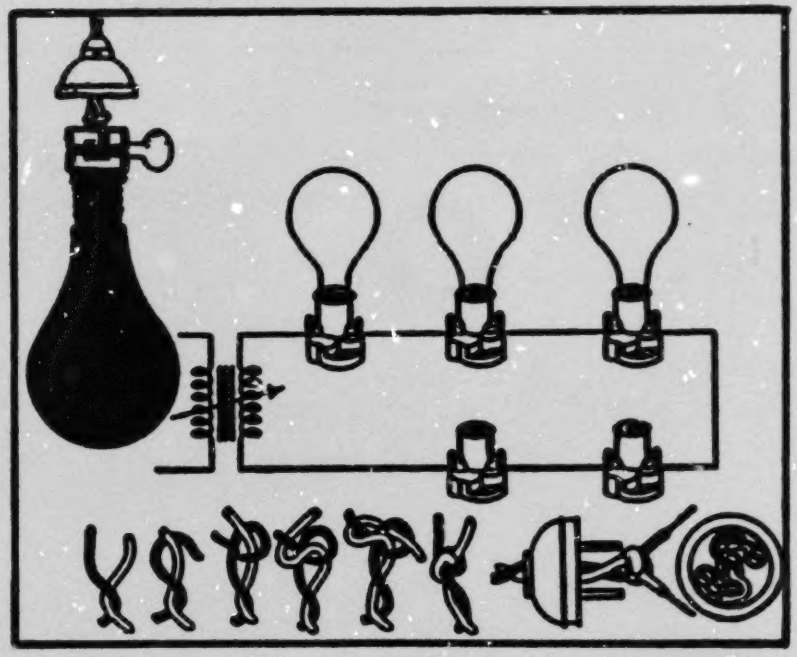
LIGHTING LEVEL 2
STANDARDIZED CURRICULUM



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Foreword

This Standardized Trade Electricity Curriculum was designed to provide vocational training for young persons of high school age who have shown an aptitude for the electrical trades and expressed a desire to enter them. This curriculum also may be used fully or in part in alternate programs such as Shared Instruction and After School Occupational Skills. In addition, individual modules can be used in Special Education Programs and Adult Occupational Training.

The content has been organized into three major divisions: Signal Wiring - Level One; Lighting - Level Two; Motors and Controls - Level Three. Each division contains a number of specific modules with several jobs within each module. The entire curriculum is designed to be taught in 1200 hours. The third division is comprised of several optional modules enabling schools to select modules which best suit their needs, fully or in part.

The aim of the total curriculum is to provide a broad foundation of basic skills and information, the mastery of which should enable the student to enter the electrical industry as a worker and also make it possible for the student to pursue advanced training.

Acknowledgments

The Standardized Trade Electricity Curriculum, Lighting - Second Level for the New York City High Schools was developed during the OCE 1981 Summer Curriculum Project. The project was initiated by the Office of Occupational and Career Education, George R. Quarles, Chief Administrator; Dr. Howard Friedman, Deputy Administrator; and Mary Gaskin, Director of Support Services. The development of instructional guides for standardizing vocational programs was under the direction of the Bureau of Trade and Technical Education, John B. Vitale, Assistant Director and the Occupational Curriculum Unit, Anne McCarthy, Consultant.

Overall supervision was provided by the Occupational Curriculum Unit, Jack H. Dixon, Coordinator, with the assistance of Dr. Arthur Golomb, Curriculum Specialist and Brenda Fryson, Basic Skills Specialist.

Members of the curriculum writing committee were Daniel S. Immordino, Assistant Principal - Supervision, Electrical Installation and Practice at William E. Grady Vocational/Technical High School and Saverio Sandonato, Assistant Principal - Supervision, Building Trades at Thomas A. Edison Vocational/Technical High School. The text was edited by Benita Daniels. Illustrations were provided by Peter Battaglia, Assistant Principal - Supervision, Related Technical Subjects at Alexander Hamilton Vocational/Technical High School.

The bulletin was reviewed and prepared for printing by the members of the Editorial/Production Unit of the Office of Curriculum Development and Support, Dr. Morris Freedman, Director. OCDS is a part of the Division of Curriculum and Instruction, Charlotte Frank, Executive Director.

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BASIC SKILLS

SUGGESTIONS FOR IMPLEMENTATION

STRATEGIES FOR REINFORCING RELATED MATHEMATICS, READING AND COMMUNICATION SKILLS THROUGH OCCUPATIONAL EDUCATION

REINFORCING RELATED BASIC SKILLS

Increased employer demands, coupled with fierce competition for employment in many occupational areas, have made it vital that students moving into the job arena be totally prepared to obtain and hold jobs. The experienced vocational instructor has long understood that preparation for the job market does not end with the development of hands-on skills. The incorporation of related reading, communications and mathematics skills into the Trade Electricity course of study represents a comprehensive approach to teaching which will enhance opportunities for future job success.

The strategies and activities which can be designed for the purpose of basic skills reinforcement are limited only by the imagination of the individual instructor. Each instructor must decide, based upon the needs of his/her students, what methods work best. Traditional student participatory activities such as preparing reports, viewing films, taking field trips, planning and completing electrical projects, all present opportunities for basic skills reinforcement.

This curriculum guide in Trade Electricity clearly outlines the hands-on operations which should be covered during the course work. The second and third columns of this guide also include references to tasks which require a certain level of competency in mathematics, reading and communications, if the student is to fully grasp the course content. The items provide opportunity for REVIEW and PRACTICE of related basic skills within the confines of the shop setting.

The instructor of trade electricity can use these topics and subtopics to build basic skills activities into daily lessons. It is important to note that the primary responsibility for TEACHING academic competencies rests with the teachers of those subjects. However, the concept of REINFORCEMENT allows the teacher of Trade Electricity to focus on those reading, mathematics and communications skills which relate directly to the trade area.

The concept of reinforcement encompasses the two types of teaching strategies mentioned earlier: REVIEW and PRACTICE.

Review

Basic skills review exercises in the electrical shop setting can take the form of "mini-lessons" which can be presented as an integral part of class sessions devoted to "shop theory" or "related technical information." These activities should be planned in conjunction with the development of the hands-on skills.

A review of the Trade Electricity course of study will reveal mathematics, reading and communication skills which will help to maximize student performance or understanding of a particular task or topic. Each of these skills can then be reinforced at the most appropriate times during the course work. For example, a review of Ohm's Law may also involve a review of:

- -problem-solving techniques
- -methods of working with formulas
- -multiplication and division of fractions

These math skills can again be reviewed when other electrical formulas are introduced.

Examples of Related Basic Skills Review Activities

Review Ohm's Law Discuss how to calculate voltage drop in a series circuit E = I x R

Review reading skills: reading and understanding technical data Develop hints for interpreting technical data Examples: -Look up any unfamiliar words -Try to put complicated passages into your own words.

Practice

Practice exercises provide opportunity for the student to develop and examine the skill which has been reviewed during the class session. Here are some examples of the types of activities which encompass both basic skills reinforcement and job preparation:

.using the correct names of tools and machines while performing hands-on operations

.using actual materials (metal, wood, etc.) for accurate measuring

.using order forms and message blanks to reinforce spelling and writing skills

.using sample civil service examinations to improve test-taking techniques

.using proofreading methods to check sentence structure and punctuation

With the increased emphasis on strengthening basic skills, many teachers have begun to compile comprehensive files of worksheets/assignment sheets which they use in a variety of teaching situations. These exercises often are used for homework assignments, student assessment or classroom practice.

The two assignment sheets which follow illustrate how information related directly to the electrical trades can be used to develop student worksheets which help to reinforce basic skills. In the first example, the student clearly sees that ability to read and interpret information presented in chart form is a job-related skill which must be mastered. The second assignment sheet reminds the student of the importance of systematic note-taking in the classroom as well as in some on-the-job situations.

Sample Assignment Sheet

TRADE ABBREVIATIONS AND SYMBOLS

As you have seen, many abbreviations and symbols are used in the electrical trade. You must be familiar with these abbreviations and symbols and know how to write them correctly if you plan to work in this field.

DIRECTIONS: Complete the exercise by filling in the missing information. Double-check your work from your classroom notes.

	TERM	ABBREVIATION/SYMBOL
1.	Direct Current	_____
2.	National Electral Code	_____
3.	Constant Ringing Drop	_____
4.	Kilowatt	_____
5.	Volt	_____
6.	Horsepower	_____
7.	Holding Coil	_____
8.	Open Coil	_____
9.	Grounded Coil	_____
10.	Shorted Coil	_____

Sample Assignment Sheet

FUEL WASTE DUE TO HIGH NIGHT SETTINGS

DIRECTIONS: Study the information presented in the chart. Answer each question by referring to the data in the chart

FUEL WASTE DUE TO HIGH NIGHT SETTINGS

Lowered Night Temperature degrees F	Savings in Oil (per cent) when Temperature is Lowered at Night			
	4 hours	8 hours	12 hours	16 hours
70	0	0	0	0
65	2.5	5	7.5	9.5
60	5	9.5	14.5	19.5
55	7.5	14.5	21.5	28.5
50	9.5	19.5	28.5	38.5

1. When the night temperature is lowered to 60° for 8 hours what percentage of oil is saved?_____.
2. What is the difference in savings for 4 hour period when the temperature is set at 65° and 55°? _____.
3. A 21.5% savings in oil can be realized when the temperature is set at____degrees F for____hours.
4. When the night temperature is lowered to 55° for 12 hours, there is a____% savings in oil.
5. Why do you think there is no oil savings when the temperature is set at 70°F? (Answer in a complete sentence) _____

_____.

BASIC SKILLS OVERVIEW

For purposes of establishing a workable and realistic teaching framework for the instructor, basic skills may be defined as those reading, mathematics and communication skills which are essential to:

-the student's overall understanding of the tasks, knowledges and appreciatiors which form the the course of study

-the student's ability to eventually perform satisfactorily as a worker in a job setting.

-the student's ability to pass:

Standardized academic examinations
Occupational licensing examinations

Specifically, these skills may be viewed within the following broad categories:

-READING COMPREHENSION

-VOCABULARY DEVELOPMENT

-COMMUNICATIONS

-WRITING
-SPEAKING and LISTENING

-MATHEMATICS

The chart on the following page lists several subskills under each broad category. These subskills denote areas in which reinforcement would be most pertinent to students enrolled in vocational courses. Following the chart are discussions of each of the major basic skills categories and methods by which these subskills can be presented for review and practice throughout the course.

RELATED BASIC SKILLS	
READING COMPREHENSION SKILLS	**MATHEMATICS SKILLS**
Understanding written directions Reading for location of specific details Reading for understanding of overall concept or idea Reading to infer meaning Learning technical terms Learning to sound out words Learning word parts (related roots, prefixes and suffixes)	Counting Adding whole numbers, fractions, decimals Subtracting whole numbers, fractions, decimals Multiplying whole numbers, fractions, decimals Dividing whole numbers, fractions, decimals Problem-solving (using equations, formulas, geometric principles) Problem-solving (understanding related word problems Understanding the metric system
WRITING SKILLS	**SPEAKING AND LISTENING SKILLS**
Using correct capitalization and punctuation Understanding sentence structure (basic grammatical concepts) Using technical terms Learning helpful spelling rules Learning to sound out words Using the dictionary	Using standard English Practicing appropriate voice volume Relating and receiving directions Relating and receiving specific details Interpreting information and meaning Drawing conclusions Relating and receiving non-verbal messages Using technical terms

Writing Skills

By emphasizing the mechanics of spelling, punctuation, word usage and sentence structure in a variety of simulated work-related situations, the instructor will be able to help students understand the practicality of what they often perceive as an abstract notion which has no meaning in the real world.

Each pre-vocational and occupational subject will require a different level of proficiency with respect to writing skills. As needs arise, practice can be given with particular rules that are used frequently. Thus, the instructor must make an initial analysis of the writing skills which are required for adequate job performance in the electrical trades. There are, however, common areas of student deficiency, which include the inability to:

-Compose complete sentences

-Use words correctly in sentences (grammar)

-Use words appropriately (including technical terms)

-Spell words correctly

-Punctuate sentences correctly

-Write legibly

Improvement in these area is based upon the systematic inclusion of these skills in classroom activities. The use of actual materials such as order blanks, sales slips, work orders and bills of materials will require the student to apply basic writing standards to job-related situations. If students understand from the outset that all written work will be checked for adherence to these standards, they will be more conscious of not only what they write, but how they write it.

Reading Comprehension

The advantage of having available printed material which is of high student interest is an invaluable aid in the reinforcement of reading comprehension skills. Those students who have experienced difficulties with reading in other areas can be motivated and provided with numerous opportunities for achievement. Other students will be fascinated with the variety of reading materials which are pertient to the electrical trades.

Textbook passages, professional journals, catalogs and schematic drawings are examples of the types of reading materials which may be used. From these, reading comprehension exercises which emphasize specific skill reinforcement may be developed.

Several strategies can be utilized to assist in strengthening reading competencies:

- -Emphasizing the importance of improving specific comprehension skills
- -Using a wide variety of printed materials, including schematic drawings and municipal codes
- -Constructing a variety of comprehension questions which are keyed to related reading materials
- -Introducing unfamiliar terms prior to making a reading assignment
- -Assigning short reading passages for thorough understanding
- -Reviewing basic components of electrical codes and other standard references
- -Emphasizing good study skills
- -Emphasizing concise note-taking

Vocabulary Development

Each professional area has its own unique set of terms. These are highly specialized words and phrases which are peculiar to the particular profession. Mastery of these terms contributes directly to a more thorough understanding of the course work.

It is suggested that terms related to the electrical trades be used as the basis for the development of individual notebook glossaries. Thus, as new topics are presented, the related vocabulary is introduced as an integral part of the overall lessons. It is more effective to explore six or seven new words or phrases within the context of a skills lesson than to present twenty or thirty such terms in an isolated and unrelated learning situation. The systematic building of a notebook glossary allows the instructor to easily review key terms and to reinforce spelling, pronunciation and usage (oral and written).

As a result of this approach to new terminology, the instructor will find it possible to emphasize more general areas of vocabulary development. These include:

-Recognition of common prefixes, suffixes and roots
-Division of complex words into syllables
-Identification of commonalities in spelling
-Use of the dictionary and other reference materials

(Here, the student is encouraged to decide upon the meaning of an unfamiliar word based upon his/her knowledge of other words in the sentence.)

Oral Communications (Speaking and Listening)

Perhaps the most overlooked components in the basic skills compendium are the speaking and listening skills. Yet, competency in these areas is critical to future job success. Additionally, the very nature of the learning activities requires students to employ these critical skills.

By building an awareness of common errors and focusing on the dynamics involved, the instructor can assist in developing solid communication skills. For example, following oral directions is an activity which is a fundamental component of the teaching/learning process. This process includes several clearly defined steps which can be presented for review and practice. They are:

-Listening to and interpreting the entire explanation

-Understanding and determining the steps involved

-Completing and checking each step before proceeding to the next

-Verifying (checking) the entire action taken and the results obtained

Classroom simulations which approximate actual on-the-job situations lend excitement and realism to the systematic practice which is neccessary for achievement in this area. These activities can be enhanced by use of the tape recorder and video tapes which allows the students to hear and see themselves in various situations. Even more germane to student performance is the example set by the instructor. By stressing acceptable English, speaking slowly and distinctly and responding carefully to questions, the teacher sets the standards which will carry over into other life experiences.

Mathematics Skills

Instruction which draws on realistic settings and problems in strengthening computational skills helps students transfer this learning to new situations. Additionally, the realization that most students will eventually become workers, taxpayers and consumers, opens up a wide range of possibilities for demonstrating the importance and practicality of possessing a sound background in mathematics.

Many students exhibit a fear of mathematics. The exploration of mathematical concepts and operations in the electrical shop can provide them with opportunities for achievement in an area of critical need.

The key to student achievement is the presentation of the skills in easily manageable components. The use of teacher-made assignment sheets and/or career-oriented workbooks is an effective means of practice and review which need not detract from classroom time.

Mathematical operations lend themselves to efficient division into subskills which can be explored as a part of the total lesson. The following suggestions may assist the instructor in the reinforcement of a related computational skill.

-Present the concept within the context of a vocationally-related-application
-Review the fundamental steps in the operation
-Provide opportunity for group discussion and practice
-Provide assignments which include vocationally-related word problems

IDENTIFYING RELATED BASIC SKILLS

This basic skills checklist will help in the identification of discreet subskills and on-the-job applications which are most relevant to Trade Electricity.

Basic Skills Checklist

Trade Electricity

1. What specific math skills should be emphasized during the teaching of this course?

   ( ) Adding whole numbers _____fractions_____decimals_____

   ( ) Subtracting whole numbers_____fractions_____decimals_____

   ( ) Multiplying of whole numbers_____fractions_____decimals_____

   ( ) Dividing of whole numbers_____fractions_____decimals_____

   ( ) Using equations and formulas

   ( ) Understanding geometric principles (angles, volume, area)

   ( ) Other

   _____

   _____

2. What measuring instruments or devices are used in this occupational area?
   (Examples: ruler, micrometer, voltmeter)

   _____ _____ _____

   _____ _____ _____

3. What actual on-the-job applications of math skills in this occupational area should be emphasized during the teaching of this course?
   (Examples: measuring wire, computing sales tax, calculating bills of materials)

   _____

   _____

4. What specific reading skills should be emphasized during the teaching of this course?

( ) Understanding written directions
( ) Reading charts and schematic drawings
( ) Identifying and interpreting specific details
( ) Determining meanings of unfamiliar technical terms
( ) Understanding trade abbreviations and symbols
( ) Other

_____

_____

5. What teaching strategies for improving reading comprehension skills could be incorporated into the teaching of this course?

( ) Use of textbook
( ) Use of job sheets
( ) Other
( ) Use of information sheets
( ) Use of newspapers and trade journals
( ) Use of manufacturer's specifications

_____

_____

_____

6. What actual on-the-job applications of reading and communication (written and oral) skills in this occupational area should be emphasized during the teaching of this course?

( ) Reading manuals
( ) Using standard references
( ) Writing orders
( ) Talking to customers
( ) Other
( ) Writing complete sentences
( ) Using correct punctuation
( ) Capitalizing in abbreviations and sentence

_____ _____

_____ _____

_____ _____

Unit I: Armored Cable

Level Two: Lighting
Suggested Time: *100 Hours / 150 Periods*

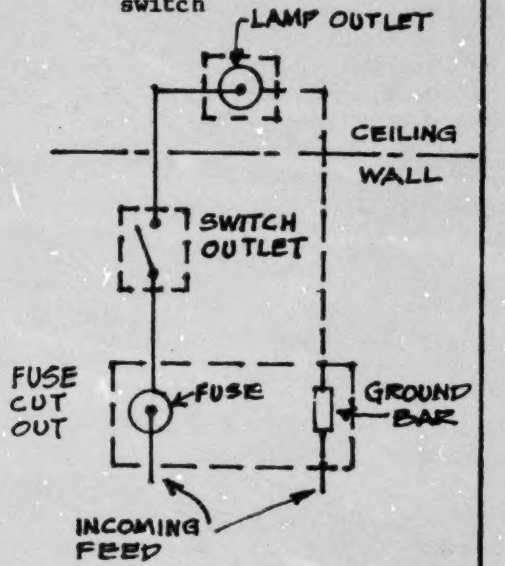
Performance Objectives

Upon completion of Unit I student will be able to:

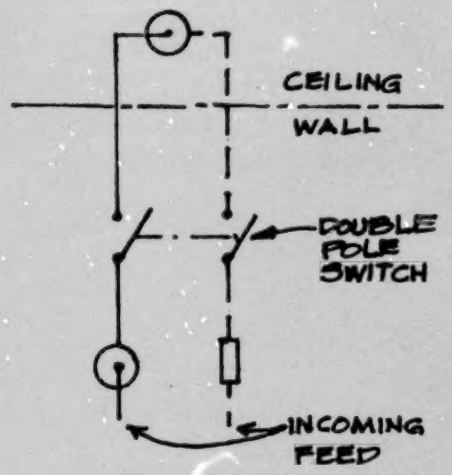
- Splice and insulate connections for lighting circuits.
- Test a lighting circuit for faults.
- Install a ceiling lamp receptacle to be controlled by a single pole switch.
- Install a ceiling lamp outlet controlled by a double pole switch.
- Install a four-circuit panel utilizing all circuits which will protect kitchen and dining room appliance circuits and house lighting.

Tasks	TEACHING CONTENT: Development of Skills	TEACHING CONTENT: Development of Related Information
1. Splice and insulate connections for lighting circuits.	Demonstrate 1. Removing insulation from wires 2. Making Western Union, single-tap and pigtail slices 3. Joining wires using solderless connectors 4. Soldering splices using soldering torch, soldering iron, soldering gun 5. Taping splices with rubber and friction tape, or with electrical plastic tape	A. Discuss 1. Types of splices a) Western Union b) Single-tap c) Pigtail B. Methods of taping splices 1. Rubber and friction 2. Electrical plastic C. Methods of joining wires 1. Wire connectors 2. Crimping tools 3. Pressure-type devices D. Methods of soldering splices 1. Torch, iron, gun E. Safety in handling hot tools and materials
2. Cut, strip, and terminate armored cable	Demonstrate 1. Cutting armor with hacksaw 2. Removing armor and paper 3. Installing anti-short bushing 4. Positioning of grounding strip 5. Attaching box connector on armor 6. Fastening cable to box with locknut	A. Discuss armored cable 1. Types and sizes 2. Where installed 3. National Electric Code regulations B. Discuss preparing of armored cable 1. Hacksaw and type blades 2. Cable removers 3. Safety in cutting

3. Install two live ceiling lamp receptacles on 4" boxes. Feed from cutout box on wall.	A. Develop job circuit on chalkboard B. Demonstrate: 1. Mounting ceiling boxes 2. Mounting cutout 3. Preparing, supporting, and fastening cable C. Demonstrate wiring of circuits using armored cable D. Test job for correct operation	Diagram development 1. Equipment layout plan 2. Converting to wiring diagram 3. Symbols 4. Color coding conductors 5. Denoting wires in a raceway
4. Test a lighting circuit for faults. The circuit is to include three live wall outlets controlled from a wall cutout.	A. Develop job circuit on chalkboard B. Review mounting of equipment C. Demonstrate: 1. Test for ground 2. Test for shorts 3. Test for opens D. Review job wiring procedures E. Test for correct operation	A. Discuss meaning of grounds, shorts, and opens B. Describe procedures for locating grounds, shorts, and opens

Tasks	TEACHING CONTENT: Development of Skills	TEACHING CONTENT: Development of Related Information
5. Install a ceiling lamp receptacle to be controlled by a single pole toggle switch. Feed to switch  Fig. #1	A. Develop job circuit on chalkboard (see fig. #1) 1. Review symbols 2. Color code B. Review mounting of equipment C. Review job wiring procedures. D. Test for correct operation from single pole switch.	A. Discuss single-pole switches 1. Construction 2. Application 3. Types 4. Code regulations 5. Switch loops
6. Install a ceiling lamp receptacle and a pendant fixture, both controlled by a single pole switch. Feed to switch.	A. Develop job circuit on chalkboard B. Discuss reason for parallel wiring. C. Demonstrate attachment of pendant fixture to box stud. D. Review job wiring procedures. E. Test for correct operation.	A. Discuss pendants 1. Types and uses 2. Code regulations B. Discuss Pendants 1. For hanging ceiling receptacles 2. Four mounting wall switch boxes.

7. Install two wall lamp receptacles to be controlled by a single pole switch and a ceiling fixture to be live. Feed to lamp receptacle.	A. Develop job circuit on chalkboard. 1. Review developing a wiring diagram from an equipment layout plan. B. Demonstrate how to attach a ceiling chain fixture. C. Review job wiring procedures. D. Test for correct operation.	A. Discuss chain fixtures 1. Types and uses 2. Code regulations B. Describe methods of hanging ceiling fixtures.
8. Install two ceiling lights and a duplex receptacle on the wall, whereby lights are controlled by a single pole switch. Feed to duplex receptacle.	A. Develop job circuit on chalkboard. B. Demonstrate how to attach a stem fixture to a box stud. C. Review job wiring procedures. D. Test for correct operation of lights and duplex.	A. Discuss stem fixtures 1. Types and uses 2. Code regulations B. Discuss types of insulation used in fixtures C. Discuss types of insulation used in general wiring.

Tasks	TEACHING CONTENT: Development of Skills	TEACHING CONTENT: Development of Related Information
9. Install a ceiling lamp outlet controlled by a double pole switch. Feed to switch.  Fig. #2	A. Develop job circuit on chalkboard. (See Fig. # 2) 1. Demonstrate identification of terminals on double pole switches. B. Review mounting of equipment. C. Review job wiring procedures. D. Test for correct operation.	A. Discuss double pole switches 1. Types, applications 2. Internal operation 3. Code regulations B. Discuss electrical safety 1. Underwriters' Laboratories 2. National Electric Code 3. New York City Code
10. Install a ceiling lamp outlet controlled by a double pole switch. Feed to lamp.	A. Develop job circuit on chalkboard. 1. Review double pole switch application and circuitry. 2. Discuss switch loop. B. Review mounting of equipment. C. Review job wiring procedures. D. Test for correct operation.	Discuss job opportunities in electrical industry 1. Private industry 2. Municipal jobs 3. Trade unions.

11. Install two ceiling lamp outlets, each controlled by a double pole switch, whereby a fan outlet is to be energized whenever either lamp is on. Feed to switch.	A. Develop job circuit on chalkboard. 1. Discuss application for this circuit. B. Demonstrate mounting of fan. C. Review job wiring procedures. D. Test for correct operation from either switch.	Discuss operation and application of overcurrent devices. 1. Plug fuses 2. Fusestats and fusetrons 3. Cartridge fuses
12. Install three ceiling outlets controlled by a single pole switch, and a convenience receptacle to be live. Feed to ceiling outlet.	A. Develop job circuit on chalkboard. 1. Review color coding and number of wires in raceway. B. Review mounting of equipment. C. Review job wiring procedures. D. Test for correct operation.	A. Discuss plug receptacles 1. Types 2. Applications 3. Code regulations B. Discuss type of fasteners used in armored cable installations.

Tasks	TEACHING CONTENT: Development of Skills	TEACHING CONTENT: Development of Related Information
13. Install a ceiling lamp outlet controlled by a double pole switch, and a live convenience outlet.	A. Develop job circuit on chalkboard. B. Review mounting of equipment. C. Review job wiring procedures. D. Test for correct operation.	A. Discuss ampacity of conductors 1. Sizes 2. Types of material 3. Insulation 4. Temperatures
14. Install three ceiling lamp outlets of which two are controlled by a single pole switch and one is live. Add a convenience receptacle on the wall. Feed to switch.	A. Develop job circuit on chalkboard. B. Review mounting of equipment. C. Review job wiring methods. D. Test for correct operation.	Discuss code regulations regarding number of conductors permitted in outlet boxes 1. Square boxes 2. Round boxes

15. Install a switch controlled ceiling fixture a switch-controlled convenience receptacle, and a live convenience receptacle. Feed to ceiling.

A. Develop job circuit on chalkboard.
B. Review mounting of equipment.
C. Review job wiring procedures.
D. Test for correct operation.

A. Discuss code regulations regarding outlet and switch boxes in terms of
   1. Installation - new and old work
   2. Unused opening
   3. Construction specifications

16. Install a multi-light fixture controlled by a two circuit switch. Feed to switch.

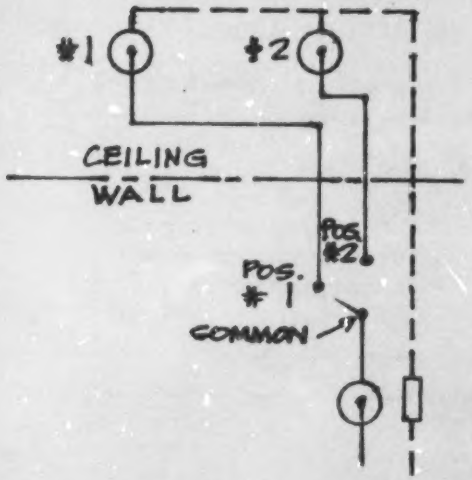


Fig. #3

A. Develop job circuit on chalkboard. (see fig. #3)
   1. Demonstrate identification of terminals on two circuit switch.
B. Review mounting of equipment.
C. Review job wiring procedures.
D. Test for correct operation.

Discuss two circuit switches
   1. Types
   2. Applications
   3. Sequence of operation
   4. Code classification

TEACHING CONTENT		
Tasks	Development of Skills	Development of Related Information
17. Install a multi-light fixture controlled by a three circuit switch. Feed to switch.	A. Develop job circuit on chalkboard. 1. Demonstrate identification of terminals on three circuit switch. B. Review mounting of equipment. C. Review job wiring procedures. D. Test for correct operation.	Discuss three circuit switches 1. Types 2. Applications 3. Sequences of operation 4. Code Classification

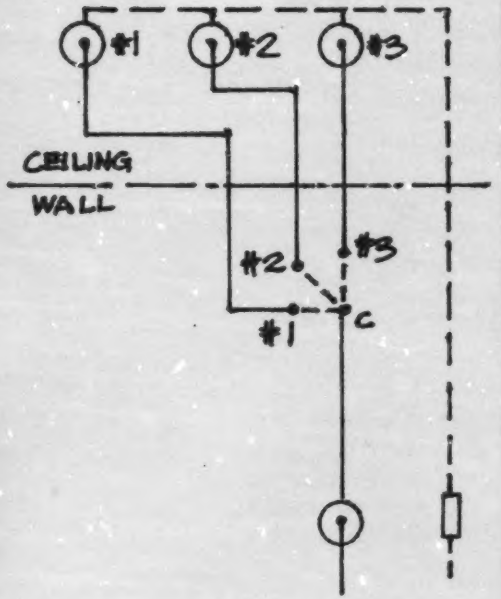


Fig. #4

18. Install two ceiling outlets controlled from two locations by three-way switches.

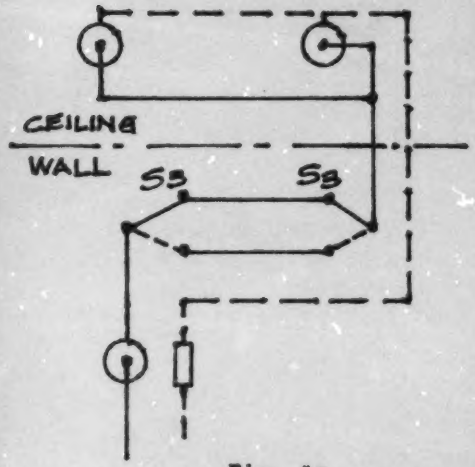


Fig. #5

19. Install two ceiling outlets, one controlled from two locations and the other to be live. Add a live convenience receptacle on the wall. Feed to convenience receptacle.

A. Develop job circuit on chalkboard. (see fig. #5)
   1. Demonstrate identification of terminals on a three-way switch.
B. Review mounting of equipment.
C. Review job wiring procedures.
D. Test for correct operation from either switch.

A. Develop job circuit on chalkboard.
   1. Review operation and circuitry of three-way switches
   2. Review how to ring out.
B. Review mounting of equipment.
C. Review job wiring procedures.
D. Test for correct operation

Discuss the three-way switch
1. Internal circuitry
2. Application
3. Code classification

Discuss code regulations for branch circuits
1. Definition
2. General provisions
3. Ratings
4. Number required in dwellings

Tasks	TEACHING CONTENT Development of Skills	Development of Related Information
20. Install two ceiling outlets, each controlled by an individual switch and a master switch to keep both lights in the "on" position.	A. Develop job circuit on chalkboard. 1. Demonstrate operation of mastering feature. B. Review mounting of equipment C. Review job wiring procedures. D. Test for correct operation from individual locations and master.	A. Discuss master switch circuits 1. Purpose 2. Switches required 3. Circuitry
21. Install a ceiling outlet to be controlled from any of three locations. Feed to three-way switch.	A. Develop job circuit on chalkboard. (see fig.#6) 1. Demonstrate identification of terminals on four-way switch. B. Review mounting of equipment. C. Review job wiring procedures. D. Test for correct operation from each location.	Discuss the four-way switch. 1. Internal circuitry 2. Application 3. Code classification

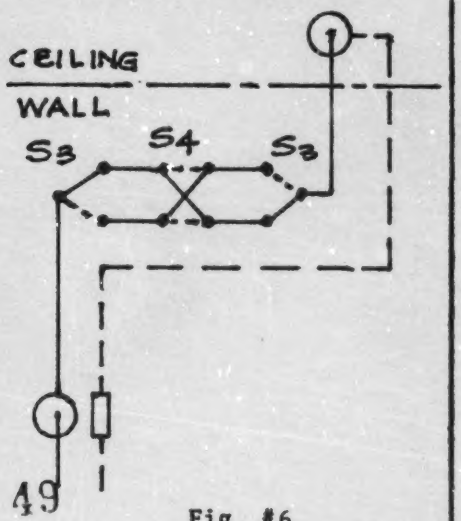


Fig. #6

22. Install two ceiling outlets controlled by a single pole switch with a pilot light to indicate whether the circuit is energized. Feed to switch.

A. Develop job circuit on chalkboard.
   1. Demonstrate operation of pilot light in circuit.
B. Review mounting of equipment.
C. Review job wiring procedures.
D. Test for correct operation.

Discuss pilot lights
1. Purpose in lighting and other circuits
2. Connections

23. Install two ceiling outlets, individually controlled from two ganged single pole switches, and a convenience outlet on the wall. Feed to convenience outlet.

A. Develop circuit on chalkboard.
B. Demonstrate mounting and use of ganged box.
C. Review job wiring procedures
D. Test for correct operation.

A. Discuss multi-switch boxes
   1. Ganged
   2. Tandem
   3. Applications

TEACHING CONTENT		
Tasks	Development of Skills	Development of Related Information
24. Install two ceiling outlets both simultaneously controlled from either of two locations. Feed to a three-way switch. Add convenience outlet located after the second three-way switch.	A. Develop job circuit on chalkboard. B. Review mounting of equipment. C. Review job wiring procedures. D. Test for correct operation of either switch and of duplex.	A. Discuss code regulations regarding lighting loads 1. General lighting 2. Feeder demand factors
25. Install a two-circuit panel, one circuit to protect a switched ceiling fixture, and the other to protect one appliance receptacle.	A. Develop job circuit on chalkboard. 1. Demonstrate how to identify connections and perform internal wiring in a two-circuit panel. B. Demonstrate mounting of panel C. Review job wiring procedures. D. Test for correct operation of individual circuits.	Discuss two circuit panels 1. Types 2. Application 3. Internal construction 4. Wiring

26. Install a two-circuit panel; one circuit to protect a two location control switched circuit of a ceiling outlet and the other to protect a switched outdoor light.	A. Develop job circuit on chalkboard. 1. Review internal wiring in panel. B. Review mounting of panel. C. Review job wiring procedures. D. Test for correct operation of individual circuits.	Discuss grounding. 1. General code regulations 2. System grounds 3. Equipment grounds
27. Install a four-circuit panel, utilizing only three circuits, whereby circuits #1 and #2 protect kitchen appliance circuits and circuit #3 protects a switched ceiling fixture.	A. Develop job circuit on chalkboard. 1. Demonstrate how to identify connections and perform internal wiring in four circuit panel. B. Demonstrate mounting of four circuit panel. C. Review job wiring procedures. D. Test for correct operation of individual circuits.	Discuss four circuit panels. 1. Types 2. Application 3. Internal construction 4. Wiring

Tasks	TEACHING CONTENT	
	Development of Skills	Development of Related Information
28. Install a four-circuit panel, utilizing all four circuits, wherein two circuits protect a 220V major appliance circuit, a third protects a switched lighting circuit, and a fourth protects a utility outlet circuit.	A. Develop job circuit on chalkboard. 1. Demonstrate internal connections for 220V circuit. B. Review mounting of equipment. C. Review job wiring procedures. D. Test for correct operation of lighting, utility, and major appliance circuits.	A. Discuss electrical life-saving procedures 1. Separating a victim from power 2. Mouth-to-mouth resuscitation 3. Treating electrical burns
29. Install a four-circuit panel, utilizing all four circuits, wherein circuits protect two kitchen appliance outlet circuits, a low voltage air-conditioner circuit, and house lighting circuits.	A. Develop job circuit on chalkboard. 1. Review panel internal connections. B. Review mounting of equipment. C. Review job wiring procedures. D. Test for correct operation of all four circuits.	Discuss test equipment used for lighting circuits. 1. Bell-battery tester 2. One/Two lamp test set 3. Neon tester 4. Megger

30. Install a four-circuit panel, utilizing all four circuits, whereby circuits #1 and #2 protect kitchen and dining room appliance circuits, #3 protects a low voltage air conditioner circuit, and #4 protects house lighting.

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A. Develop job circuit on chalkboard.
B. Review mounting of equipment.
C. Review job wiring procedures.
D. Test for proper operation of all four circuits.

A. Discuss use of power tools in lighting installations.
   1. Power drills
   2. Power saws
   3. Power hammers
B. Stress safety factors.

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Unit II: Rigid Conduit

Level Two: Lighting
Suggested Time: *100 Hours / 150 Periods*

Performance Objectives

Upon completion of Unit II the student will be able to:

- Install two wall outlets, controlled by a single pole switch, and a live convenience outlet, using rigid conduit.
- Install two ceiling outlets, each controlled from two locations by three-way switches and a convenience outlet at far end of circuit.

Tasks	TEACHING CONTENT	
	Development of Skills	Development of Related Information
1. Cut, thread and ream rigid conduit to measurement.	A. Demonstrate 1. Measuring conduit to dimension 2. Securing in pipe vise 3. Cutting rigid conduit with a hacksaw 4. Threading conduit with a standard stock and die set 5. Threading conduit with a ratchet stock and die set 6. Reaming conduit 7. Safety practice while performing all the above	A. Discuss rigid conduit 1. Construction 2. Types 3. Sizes 4. Uses B. Discuss cutting of conduit 1. Hand hacksaw 2. Power hacksaw 3. Blades used
2. Install two wall outlets controlled from a single pole switch. Feed to switch.	A. Develop job circuit on chalkboard. B. Demonstrate 1. Cutting pipe nipples to measurement 2. Setting boxes to measurement 3. Installing conduit with locknuts and bushings 4. Coupling nipples between boxes C. Demonstrate job wiring procedure in conduit D. Test job for correct operation	A. Discuss threading of rigid conduit 1. Type stocks 2. Threads per inch 3. Lubricants 4. Effect of poor dies B. Discuss rigid conduit installations 1. Exposed work 2. Concealed work

3. Bend a box offset on ½" conduit.	A. Describe need for box offset. B. Demonstrate 1. Layout of 30° angle 2. Making first bend in hickey 3. Making second bend in hickey 4. Use of slip pipe 5. Checking bend for proper rise 6. Adjusting bend, as necessary 7. Safety practices for all the above.	A. Discuss bending small sizes of rigid conduit. 1. Purpose 2. Type hickey heads 3. Use of slip pipe 4. Code regulations
4. Install two live wall outlets and a live convenience outlet.	A. Demonstrate job circuit on chalkboard. B. Review demonstration for making box offsets. C. Review coupling of nipples. D. Demonstrate supporting conduit with straps. E. Review job wiring procedures. F. Test job for proper operation.	A. Discuss code regulations for rigid conduit (Article #346). B. Discuss couplings used in rigid conduit work. 1. Threaded 2. Erickson 3. Threadless 4. Expansion

Tasks	TEACHING CONTENT	
	Development of Skills	Development of Related Information
5. Make a right angle bend (elbow) on ½" conduit.	A. Describe need for 90° elbow and display how it is used. B. Demonstrate 1. Layout of 90° angle 2. Measuring for size of stub required 3. Placement of conduit at proper position in hickey 4. Use of slip pipe 5. Take up at each "bite" with hickey 6. Finishing of bend 7. Checking bend 8. Adjusting bend, as necessary 9. Safety practices in the steps cited.	A. Discuss fasteners used in rigid conduit installations for: 1. Wood 2. Concrete 3. Brick 4. Wire lath partitions 5. Hollow tile partitions B. Discuss rigid conduit straps 1. Types 2. Uses
6. Install two wall outlets, controlled by a single pole switch, and a live convenience outlet. Use two elbows to wall outlets.	A. Develop job circuit on chalkboard (see fig. #1) B. Demonstrate testing for grounds, shorts, and opens in rigid conduit installations. C. Review mounting of equipment. D. Review job wiring procedures. E. Test job for proper operation.	A. Discuss testing for faults in rigid conduit wiring. 1. Grounds 2. Shorts 3. Continuity

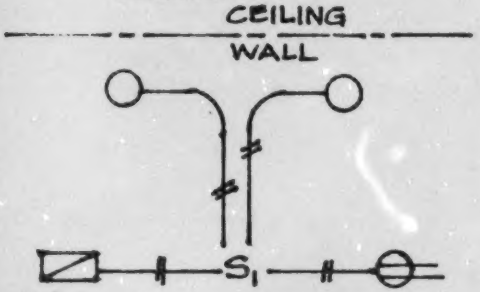

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Fig. #1

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7. Install two ceiling outlets controlled by a single pole switch. Use an elbow to one of the ceiling outlets and coupled offsets between the two ceiling outlets.

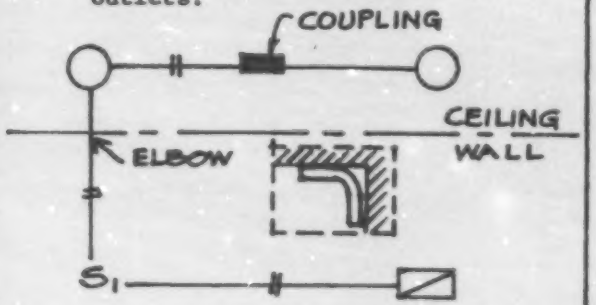


Fig. #2

A. Develop job circuit on chalkboard (See Fig. #2)
B. Demonstrate pulling of wire in conduit with a snake.
C. Demonstrate fishing for wire in conduit.
D. Review mounting of equipment.
E. Review job wiring procedures.
F. Test job for proper operation.

A. Discuss inserting wire in conduit.
   1. Fish wire (snake)
   2. Rope
   3. Lubricants
B. Discuss code regulation regarding induced currents in metal enclosures (Article 300)

8. Install two ceiling outlets, a three-way switch, and a single pole switch, whereby the three-way switch provides alternate control of lights and the single pole acts as a main switch.

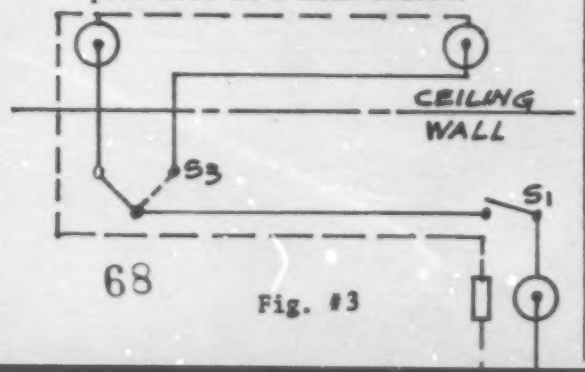


Fig. #3

A. Develop job circuit on chalkboard. (See Fig. #3)
   1. Point out applications for the circuit.
B. Review mounting of equipment.
C. Review job wiring procedures.
D. Test job for proper operation.

A. Discuss maximum number of conductors permitted in various sizes of conduit.
   1. Chapter 9, Tables 1, 3A, 3B, and 3C.
   2. Practice using N.E.C. for above.

Tasks	TEACHING CONTENT: Development of Skills	TEACHING CONTENT: Development of Related Information
9. Bend a three-point saddle on ½" conduit.	A. Describe the need for the three-point saddle and display how it is used. B. Demonstrate 1. Laying out of angle for the bend 2. Making conduit according to height of obstruction 3. Setting conduit at proper point on hickey 4. Making first two bends (similar) 5. Reversing conduit and making two finishing bends 6. Checking bends and adjusting, if necessary C. Safety practices for all the above	A. Discuss types of saddles used on rigid conduit . 1. Purpose 2. Places where used 3. Determining allowances for height of bends 4. Methods of adjusting bends 5. Correcting wows
10. Install two ceiling outlets, each controlled from two locations by three way switches. Use an elbow to each ceiling outlet and a three point saddle between switches	A. Develop job circuit on chalkboard. (See Fig. #4.) B. Review two location control of lights. C. Demonstrate installation of three point saddle. D. Review job wiring procedures. E. Test job for proper operation.	A. Discuss conductors used for general wiring. 1. Types 2. Applications 3. Temperature 4. Use of Article 310, N.E.C.

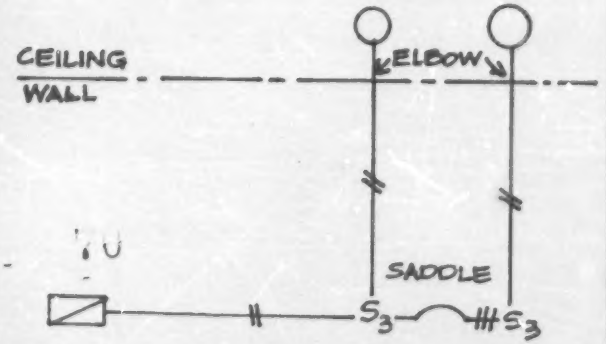
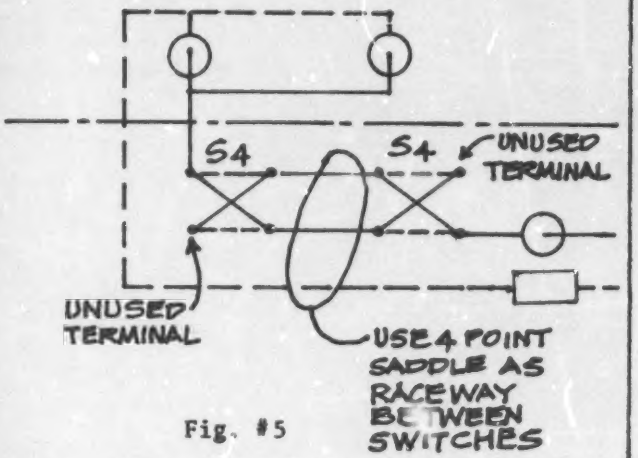


Fig. #4

11. Bend a four-point saddle on ½" conduit.

A. Describe need for the four point saddle and display how it is used.
B. Demonstrate
    1. Laying out of angle for the bend
    2. Making conduit according to height of obstruction
    3. Setting conduit at proper
    4. Making first two bends (similar)
    5. Reversing conduit and making two finishing bends
    6. Checking bends and adjusting, if necessary
C. Safety practices for all the above

A. Discuss pull and junction boxes (Article 370, N.E.C.).
    1. Installation
    2. Minimum sizes
    3. Number of conductors in boxes.
    4. Calculating volume of boxes, including practice

Tasks	TEACHING CONTENT	
	Development of Skills	Development of Related Information
12. Install two ceiling outlets, each controlled from two locations, and a live convenience outlet. Use four-way switches in place of three-way switches and a four-point saddle between switches.  Fig. #5	A. Develop job circuit on chalkboard. (See Fig. #5.) B. Demonstrate circuitry and operation of four-way switches in place of three-way switches. C. Review mounting of equipment. D. Review job wiring procedures. E. Test for proper operation from either switch.	A. Determine approximate lengths in coils of: 1. Wire 2. Cable 3. Rope Formula: Length = D X TT(3.14)
13. Install two ceiling outlets, both controlled from two locations, and a live convenience outlet. Use one three-way and one four-way switch for control, and join the conduit between ceiling outlets with an Erickson coupling.	A. Develop job circuit on chalkboard. B. Demonstrate circuit operation of three-way and four-way switch combination. C. Demonstrate installation of Erickson coupling. D. Review job wiring procedures. E. Test for proper operation from either switch.	A. Discuss code regulations regarding hazardous locations (Article 500) 1. Precautions 2. Equipment marking 3. Temperature 4. Classes and divisions

14. Install two ceiling outlets, both controlled from two locations by three-way switches, and a convenience outlet at the far end of the circuit. Feed to switch. Use only four wires between switches.

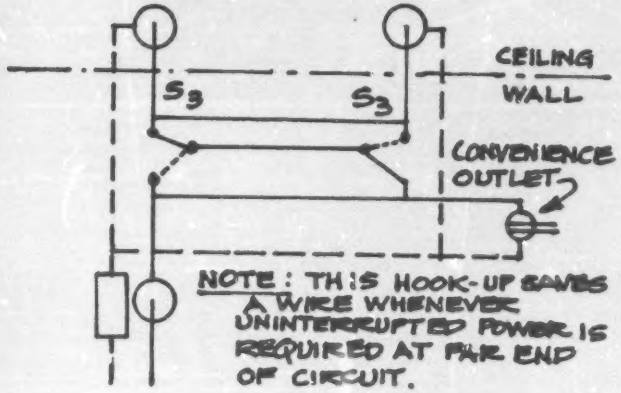


Fig. #6

15. Install two ceiling outlets, controlled from two locations by three-way switches, and a convenience outlet at the far end of the circuit. Feed to ceiling outlet.
Use special four wire circuit between switches.
Use LR conduit bodies (condulets) in runs from wall to ceiling.

A. Develop job circuit on chalkboard. (See Fig. #6)
B. Point out economy of special four wire connection.
C. Review mounting of equipment.
D. Review job wiring procedures.
E. Test for proper operation from either switch.

A. Develop job circuit on chalkboard.
B. Demonstrate installation of several types of conduits
C. Review job wiring procedures.
D. Test job for proper operation from either switch.

A. Discuss clamp-on volt-ammeter.
   1. Construction
   2. Advantage
   3. Theory of operation
   4. Meter ranges
   5. Practice in reading various values of voltage and current.

A. Discuss conduit bodies (conduits)
   1. Purpose and applications.
   2. Types - LL, LB, LR, T, C, LBL, LBR, LRL, X.

Tasks	TEACHING CONTENT: Development of Skills	TEACHING CONTENT: Development of Related Information
16. Install two ceiling outlets controlled from three locations. An LL condulet is to be used between cut out and run to switch.	A. Develop job circuit on chalkboard. (See Fig. #7.) B. Review three location of lights. C. Review demonstration for installing condulets. D. Review job wiring procedures. E. Test job for proper operation from each location.	A. Describe and display various type of wire and cable fittings. 1. Purpose 2. Application for types 3. Crimping tool 4. Soldering lugs, solderless lugs, split-bolt connectors, wedge-grip connectors.

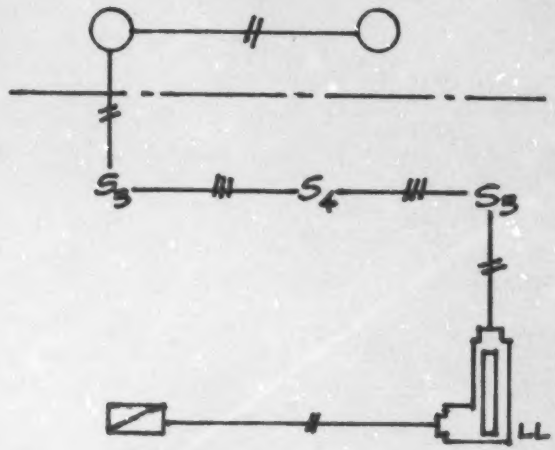


Fig. #7

17. Install two ceiling outlets, each controlled by a single pole switch, and a double pole switch to master both lights.

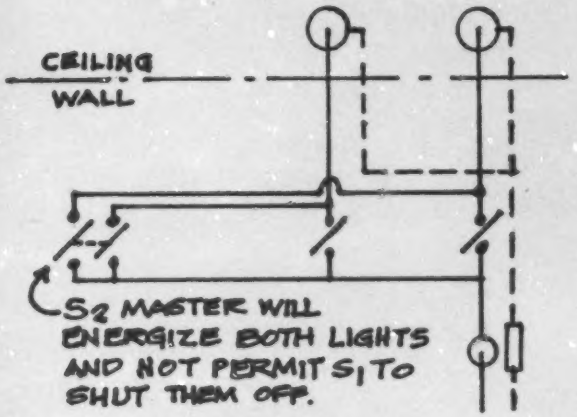


Fig. #8

A. Develop job circuit on chalkboard. (See Fig. #8.)
B. Review circuitry for master lighting.
C. Review mounting of equipment.
D. Review job wiring procedures.
E. Test job for proper operation from each switch.

Discuss allowable ampacity of conductors (Article 310, N.E.C. Tables 16, 17, 18, 19)

1. Copper and aluminium
2. Raceway or free air
3. Temperature ratings

TEACHING CONTENT		
Tasks	Development of Skills	Development of Related Information
18. Install a multi-light fixture controlled by a two circuit switch. Use an LR condulet from cut out to switch.	A. Develop job circuit on chalkboard. B. Review construction and operation of two circuit switches. C. Review mounting of equipment including LR. D. Review job wiring procedures E. Test for proper operation	A. Discuss anchoring devices. 1. Purpose 2. Types and their applications: toggle bolts, machine screw anchors, expansion shields 3. Tools used for anchoring
19. Install a multi-light fixture controlled by a three circuit switch. Use a three-point saddle between cut out and switch.	A. Develop job circuit on chalkboard. B. Review construction and operation of three circuit switches. C. Review making a three point saddle. D. Review mounting of equipment. E. Review job wiring procedures. F. Test job for proper operation.	A. Discuss grounding and bonding. (Article 250, N.E.C.) 1. Systems, circuits, and equipment required or not permitted to be grounded 2. Circuit conductor to be grounded 3. Location 4. Types and sizes of grounding and bonding conductors and electrodes 5. Methods

20. Install four ceiling outlets controlled from two ganged single pole switches, whereby each switch controls two outlets.

A. Develop job circuit on chalkboard.
B. Demonstrate installation of ganged switch boxes.
C. Explain reason for ganging
D. Review job wiring procedures
E. Test for proper operation.

21. Install a red and green traffic signal, manually controlled from two locations by using a three-way and a four-way switch.

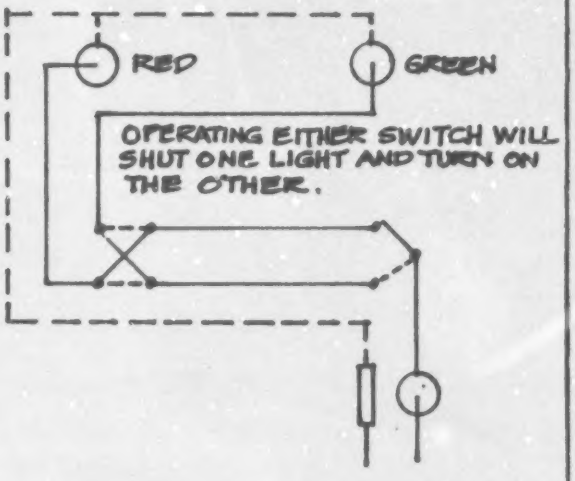


Fig. #9

A. Develop job circuit on chalkboard. (Fig. # 9).
B. Review traffic signal circuit.
C. Review mounting of equipment.
D. Review job wiring equipment.
E. Test for proper operation.

Discuss the three phases, four wire, WYE system.
1. Circuitry
2. Grounding
3. Voltages available
4. Tapping for lighting

Discuss the three phase, four wire, Delta system.
1. Circuitry
2. Grounding
3. Voltages available
4. Tapping for lighting

Tasks	TEACHING CONTENT Development of Skills	Development of Related Information
22. Install a ceiling outlet controlled from a single pole switch with a pilot light to indicate that the ceiling outlet is energized. Use a condulet in run to go from wall to ceiling.	A. Develop job circuit on chalkboard. B. Review purpose and circuitry for pilot lights. C. Review use and installation of condulets. D. Review job wiring procedures. E. Test job for proper operation.	A. Discuss rope knots used in electrical installations. 1. Type rope 2. Rope sizes 3. Typical knots: square, bowline, half hitch, clove hitch
23. Install two ceiling outlets, controlled by individual double-pole switches, and a pilot light to indicate when either light is on. Use a four point saddle between switches.	A. Develop job circuit on chalkboard. (See Fig. #10). B. Review use and circuitry for double pole switches. C. Review making a four point saddle. D. Review job wiring procedures. E. Test job for proper operation.	A. Discuss flexible cords and cables (Article 400, N.E.C.) 1. Trade name 2. Type letter 3. No. of conductors 4. Insulations 5. Outer covering 6. Use

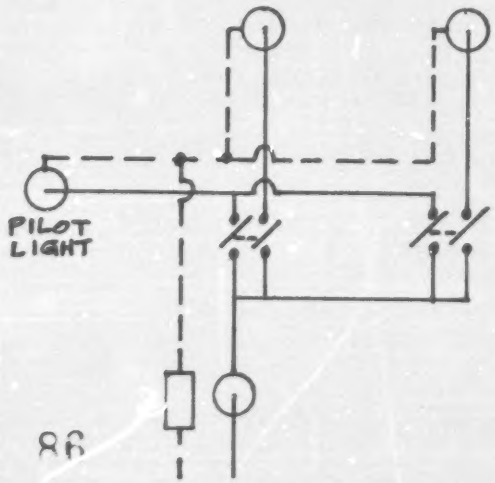


Fig. #10

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24. Install a combination heater, light, and exhaust fan unit in a bathroom.
Wire so that the heater cannot be turned on unless the fan and light are also on. The light and exhaust fan combination may be turned on individually. A pilot light will also indicate that the heater switch is on.

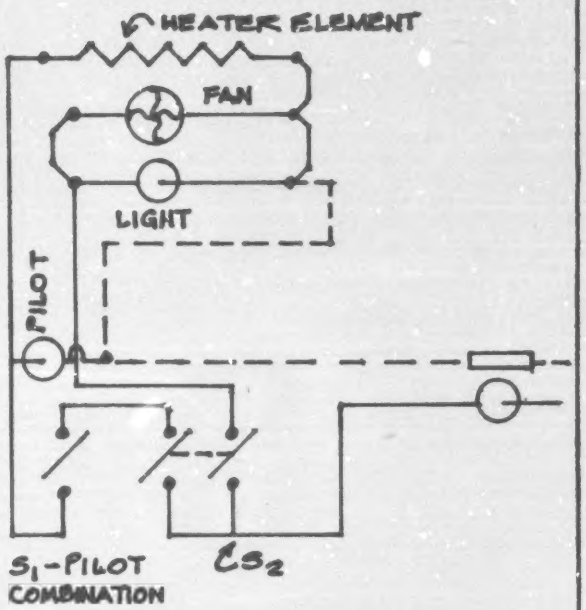


Fig. #11

A. Develop job circuit on chalkboard. (Fig. #11).
   1. Discuss special nature of this job.
   2. Discuss why heater should not be turned on unless fan and light are also on.
B. Demonstrate installation of heaters and fans.
C. Review job wiring procedures.
D. Test job for proper operation of light, fan, and heater.

Discuss plugs, receptacles, and configurations; display chart.
1. By voltage
2. By current ratings
3. Shapes
4. Locking type
5. Applications

Tasks	TEACHING CONTENT	
	Development of Skills	Development of Related Information
25. Install a six circuit, 120/208V, circuit breaker panel utilizing two circuits, whereby breaker #1 protects switched ceiling lights and #2 protects two live convenience outlet	A. Develop job circuit on chalkboard. B. Illustrate interior of typical breaker panel. C. Describe construction and wiring. D. Demonstrate installation of panel. E. Demonstrate procedure for wiring of panel. F. Review job wiring procedures. G. Test job for proper operation.	Display and discuss circuit breakers. 1. Advantages 2. Principle of operation 3. Types 4. Method of installation
26. Install a six circuit, 120/208V circuit breaker panel utilizing four circuits, whereby breaker #1 protects a convenience outlet, #2 protects house lighting, and #3 and #4 protect a 208V air conditioner outlet.	A. Develop job circuit on chalkboard. B. Demonstrate wiring and installation of single and double breakers. C. Discuss reason for use of double breaker. D. Review mounting of equipment. E. Review job wiring procedure. F. Test for proper operation of 120 volts and 208 volts circuits.	Discuss code regulations for circuit breakers (Article 240, N.E.C.) 1. Method of operation 2. Marking 3. Interrupting rating 4. Location

27. Install a six circuit 120/208V circuit breaker panel utilizing five circuits, whereby breakers #1 and #2 protect kitchen appliance circuits, #3 protects house lighting circuits, and #4 and #5 protect a 208V major appliance circuit.

A. Develop job circuit on chalkboard.
B. Review interior construction of circuit breaker panels.
C. Review mounting of equipment.
D. Review job wiring procedures.
E. Test job for proper operation of 120 volts and 208 volts circuits.

Discuss power tools used in conduit installations.
1. Power saws
2. Power threaders
3. Power benders
4. Portable work benches

28. Install a six circuit, 120/208V circuit breaker panel utilizing six circuits, whereby breakers #1 and #2 protect kitchen appliance circuits, breaker #3 protects a 120V. air conditioner circuit, breaker #4- protects lighting circuits, breakers #5 and #6 protect a 208V air conditioner circuit.

A. Develop job circuit on chalkboard.
B. Demonstrate use of all six breakers in panel.
C. Review panel wiring.
D. Review mounting of equipment.
E. Review job wiring procedures.
F. Test for proper operation of all six circuits.

Discuss voltage drop
1. Code regulation (Article 210, N.E.C.)
2. Meaning
3. Problems caused by excessive drop.
4 Method of calculation
5. Working out typical voltage drop problems.

Tasks	TEACHING CONTENT: Development of Skills	TEACHING CONTENT: Development of Related Information
29. Cut, ream, and thread one inch conduit using a power threader.	A. Demonstrate 1. Setting up machine for 1" conduit. 2. Clamping conduit in jaws. 3. Cutting conduit with pipe cutter. 4. Reaming conduit. 5. Removing of conduit B. Safety practices in all the above.	Discuss the rigid conduit power threader 1. Construction 2. Functions 3. Precautions
30. Bend an elbow on one inch conduit using hydraulic bender.	A. Demonstrate 1. Use of bending chart for bend to be make. 2. Lay out of measurement on conduit. 3. Set up of "shoes" for bending 1" conduit. 4. Placement of conduit in bender according to measurement. 5. Working handle until bend is completed. 6. Removal of conduit B. Safety practices for all the above.	Discuss the hydraulic bender 1. Construction 2. Principle of operation 3. Use 4. Use of bending chart 5. Maintenance of tool

Unit III: Electrical Metallic Tubing

Level Two: Lighting
Suggested Time: *100 Hours / 150 Periods*

Performance Objectives

Upon completion of Unit III the student will be able to:

- Cut and ream electrical metallic tubing.
- Bend a box offset on ½-in. E.M.T.
- Install three ceiling outlets, two of which are simultaneously controlled by two three-way switches and the third outlet controlled by a single pole switch.
- Install a circuit breaker panel utilizing six circuits, whereby circuits #1 and #2 are for house lighting, #3 and #4 are for kitchen appliance outlets and circuits #5 and #6 are for a 208V air conditioner.

Tasks	TEACHING CONTENT: Development of Skills	TEACHING CONTENT: Development of Related Information
1. Cut and ream electrical metallic tubing.	A. Demonstrate 1. Measuring to desired length. 2. Holding securely for cutting. (Pipe vise should not be used). 3. Choosing and using correct blade. 4. Cutting 5. De-burring (reaming) B. Stress Safety 1. Preventing injury while cutting 2. Avoiding hazards of leaving nipples on floor.	A. Discuss electrical metallic tubing 1. Construction 2. Sizes 3. Uses 4. Code regulations B. Discuss cutting and reaming. 1. Use of hacksaw 2. Type of blade 3. Use of tubing cutter 4. Reaming methods
2. Install two wall outlets controlled by a single pole switch. Bring feed to switch and use coupled nipples between outlets.	A. Demonstrate 1. Laying out nipples to be cut from full lengths of E.M.T. 2. Cutting the nipples 3. Reaming 4. Using E.M.T. coupling 5. Attaching E.M.T. to boxes with E.M.T. connectors B. Review equipment mounting. C. Review job wiring procedure (Fig. #1), D. Check installation. 1. Electrically 2. Mechanically E. Check dimensions.	Discuss types of connectors and couplings used with E.M.T. 1. Set screw type 2. Crimp type 3. Compression type

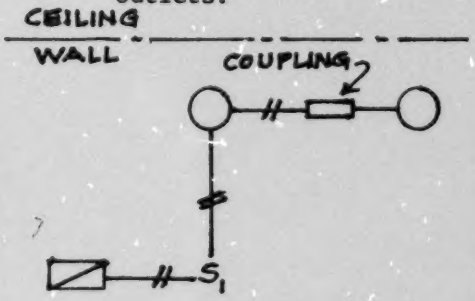


Fig. #1

3. Bend a box offset on ½" E.M.T.

A. Demonstrate need for offsets and their uses.
B. Demonstrate
   1. Bender and its features.
   2. Location of offset in relation to box.
   3. Making the first bend.
   4. Importance of "stirrup" on bender.
   5. Making second bend.
   6. Using slip pipe
   7. Checking height of offset.
   8. Making adjustments.

Discuss
   1. Types of benders
   2. Codes requirements for inside diameter of E.M.T. after bending.
   3. Manufactured offsets
   4. Need for E.M.T. to enter boxes at right angle to the box.

4. Install two wall outlets, each controlled by a double pole switch. Wire for a hazardous location. Use coupled offsets between outlets.

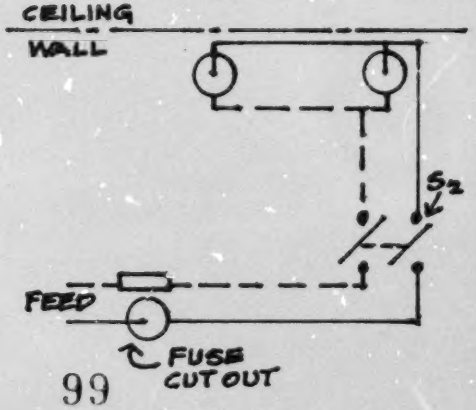
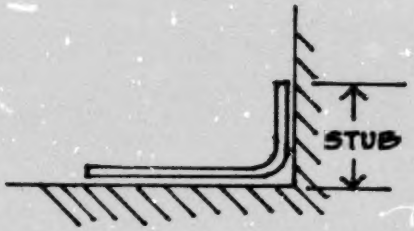


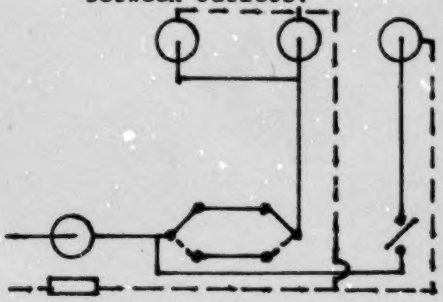
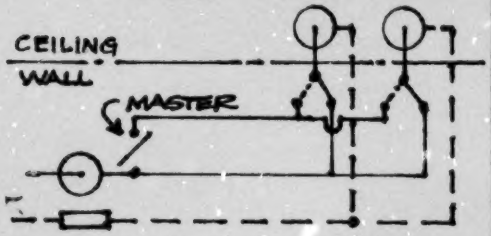
Fig. #2

A. Demonstrate job circuit on chalkboard. (See Fig. #2)
   1. Show how the return wire is interrupted.
   2. Point out extra safety feature of this circuit.
   3. Caution agains polarity reversal when wiring switch.
B. Review mounting of equipment
C. Review job wiring procedures
D. Test job for proper operation

A. Discuss code requirements for switches.
B. Define hazardous locations.
C. Justify interrupting the return wire.
D. Define simultaneous.

Tasks	TEACHING CONTENT: Development of Skills	TEACHING CONTENT: Development of Related Information
5. Make a right angle bend (elbow) on ½" E.M.T.  Fig. #3	A. Review bender features B. Emphasize mark "B" C. Demonstrate "take up" allowance D. Demonstrate 1. Determining height of stub. (Fig. #3). 2. Laying out bend 3. Placing E.M.T. in bender with layout mark at proper point. 4. Importance of stirrup. 5. Making bend 6. Checking for 90° angle. 7. Making corrections.	Discuss code requirements for bends. 1. Minimum radius. 2. Number allowed in a run. 3. Effect on internal diameter. 4. Totalling the number of degrees of bends in a run.
6. Install two ceiling outlets, controlled by individual single pole switches. Use two elbows to ceiling outlets and coupled offsets between ceiling outlets. Feed to switch.	A. Demonstrate job circuit on chalkboard. B. Review mounting of equipment. C. Review job wiring procedures. D. Test job for proper operation.	Discuss code regulations for switches (Article 380, N.E.C.) 1. Enclosures 2. Position 3. Accessibility and grouping 4. Covers 5. Mounting 6. Ratings 7. Construction specifications

7. Install two ceiling outlets, controlled by a double pole switch, and a live convenience receptacle. Wire as for hazardous location, with switch opening both legs of ceiling outlets.	A. Develop job circuit on chalkboard. B. Review construction and circuitry for double pole switches. C. Point out hazardous locations. D. Review mounting of equipment. E. Review job wiring procedures. F. Test for proper operation from both switches.	Determining the number of circuits required in a dwelling 1. Calculating occupied floor area 2. Load requirements for general lighting 3. Minimum number of lighting branch circuits 4. Minimum number of small appliance branch circuits 5. Use of N.E.C. (Article 220) to determine requirements for various branch circuits
8. Bend a three point saddle on ½" E.M.T.	A. Review the need for three point saddles and display their application. B. Demonstrate 1. Determining the rise of the saddle 2. Determining the size of the obstruction 3. Use of chart to mark bending points on E.M.T. 4. Forming the bend 5. Checking the saddle for correct size and alignment 6. Adjusting the bend, if necessary	Discuss the three point saddle and use of the instruction chart. 1. Following directions for measurements 2. Following directions for bending 3. Working out several examples for typical three point saddles

Tasks	Development of Skills	Development of Related Information
9. Install three ceiling outlets, two of which are simultaneously controlled by two-three-way switches and the third outlet controlled by a single pole switch. Use a three point saddle between outlets.  Fig. #4	A. Develop job circuit on chalkboard. (See Fig. #4) B. Review construction and circuitry of three way switches. C. Review formation of three-point saddle. D. Demonstrate installation of the three-point saddle. E. Review job wiring procedures. F. Test job for proper operation from either switch.	Discuss branch circuit feeders (N.E.C., Article 220) 1. General lighting 2. Show windows 3. Lighting load demand factors 4. Continuous and noncontinuous loads
10. Install a master control lighting system with two ceiling outlets, individually controlled by a three-way switch and a single pole switch master.  Fig. #5	A. Develop job circuit on chalkboard (See Fig. #5) B. Review purpose and circuitry for mastering. C. Review mounting of equipment. D. Review job wiring procedures. E. Test job for proper operation from each of the switches.	Discuss branch circuit feeders (N.E.C., Article 220) 1. Small appliance and laundry loads for a dwelling 2. Fixed appliance load-dwelling 3. Electric clothes dryers - dwelling 4. Electric ranges - dwelling 5. Kitchen equipment - dwelling

11. Install a three location and master control system of two ceiling outlets using one three-way and two four-way switches for simultaneous control from each of the three locations, and a single pole switch for mastering. Feed to master and four way switch.

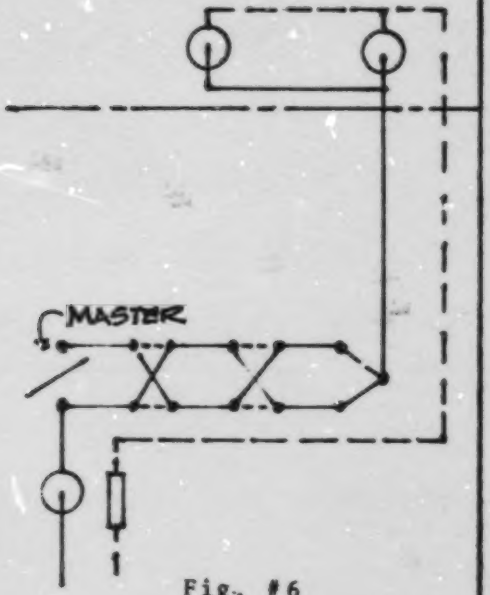
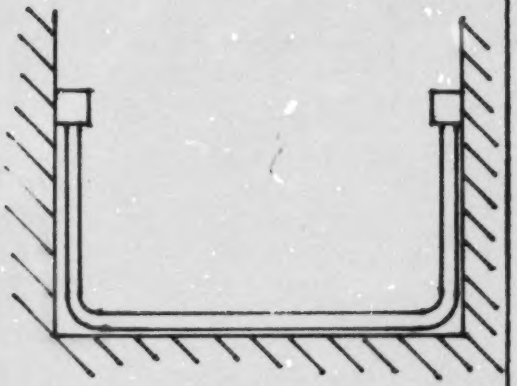


Fig. #6

A. Develop job circuit on chalkboard. (See Fig. #6).
B. Review construction and circuitry of four way switches.
C. Review circuitry for three-location control of lights.
D. Review mounting of equipment.
E. Review job wiring procedures.
F. Test for proper operation
   1. Three location control
   2. Mastering

Discuss code regulations for dimensions and percent areas for conduit and tubing (N.E.C., Chapter 9).
Use chart in conjunction with Table 1.

Tasks	TEACHING CONTENT: Development of Skills	TEACHING CONTENT: Development of Related Information
12. Make a back-to-back bend on ½" E.M.T.  Fig. #7	A. Describe use of the back-to-back bend and illustrate how it is applied. (See Fig. #7) B. Demonstrate 1. Bend first 90° stub according to height of the box using required take-up. 2. Measure distance between boxes. 3. Bend second 90° stub 4. Cut E.M.T. to enter second box. 5. Check entire bend for alignment.	Discuss lighting for a bathroom in a dwelling. 1. Surface mounted fixtures 2. Recessed fixtures 3. Code for recessed fixtures (Article 410, N.E.C.) 4. Estimating wattage 5. Equipment grounding requirements (Article 410, N.E.C.) 6. Drawing a wiring diagram
13. Install a two light ceiling fixture, controlled by a two circuit switch, and a live convenience outlet.	A. Develop job circuit on chalkboard. B. Review circuitry for two circuit switches. C. Demonstrate how to shift stubs in a vertical run of E.M.T. D. Review job wiring procedures E. Test for proper operation.	Discuss the megger 1. Describe its special applications. 2. Principle of operation 3. Reading the megger 4. Resistance measurement of various apparatus

14. Install a three light ceiling fixture controlled by a three circuit switch and a live convenience outlet.

A. Develop job circuit on chalkboard.
B. Review circuitry for three circuit switches.
C. Demonstrate how to produce uniform E.M.T. stubs in quantity.
   1. Anchoring the bender on bench
   2. Setting a block to regulate length of stub
D. Review job wiring procedures
E. Test job for proper operation.

Discuss code requirements for fixture locations (N.E.C., Article 410).
   1. Wet and damp locations
   2. Corrosive locations
   3. Ducts or hoods
   4. Pendants
   5. Show windows
   6. Clothes closets
   7. Cove lighting

15. Bend a four point saddle on ½" E.M.T.

A. Describe the use of the four-point saddle and illustrate how it is applied.
B. Demonstrate
   1. Size of obstruction and rise of the saddle
   2. Marking E.M.T. for first two bends
   3. Making first two bends
   4. Marking and forming second two bends
   5. Checking saddle for correct rise and alignment
   6. Adjusting bend, if necessary

Discuss the four point saddle and use of the instruction chart.
   1. Following directions for measurements
   2. Following directions for bending
   3. Work out several examples for typical four point saddles

Tasks	Development of Skills	Development of Related Information
16. Install two ceiling outlets, simultaneously controlled from either of two locations, and a live convenience outlet. Convenience outlet is at the far end of the circuit and only four wires are to be used between switches.	A. Develop job circuit on chalkboard. (See Fig. #8) B. Review special four wire circuit. C. Demonstrate how to straighten and rebend E.M.T. D. Review job wiring procedures. E. Test job for proper operation.	A. Discuss the wire gauge 1. Size of wire 2. Decimal equivalents 3. Measuring solid wire 4. Measuring stranded wire 5. Applications where the wire gauge is a necessity.

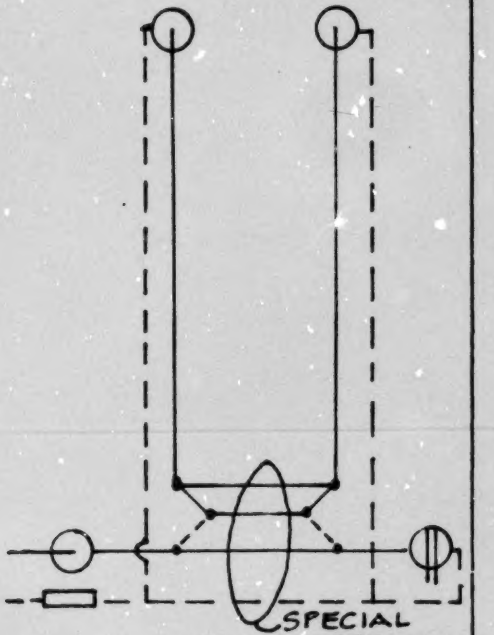


Fig. #8

17. Install two red and two green traffic lights, controlled from two locations by a three way and a four way switch.
Use a four point saddle between sets of lights.

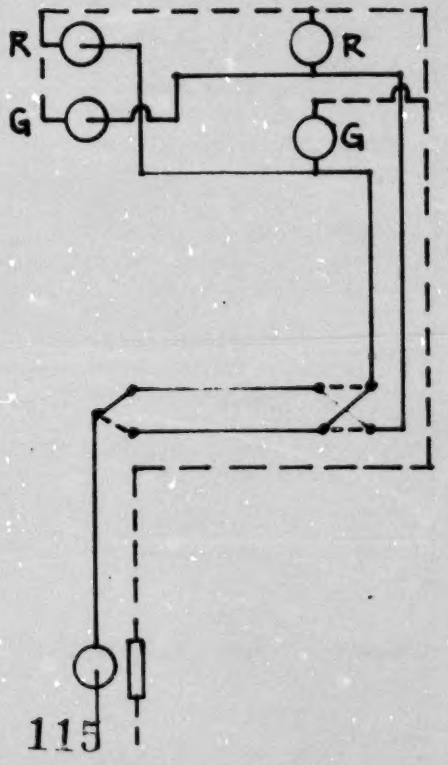


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Fig. #9

A. Develop job circuit on chalkboard. (Fig. #9)
B. Review the alternate light control circuit.
C. Review demonstration on making of four point saddles.
D. Review job wiring procedures.
E. Test for proper operation.

Discuss ground fault circuit interruptors
1. Definition
2. Personnel protection
3. Receptacles
4. N.E.C., Articles 100, 210, 215, 517, 550, 551, 555, 680

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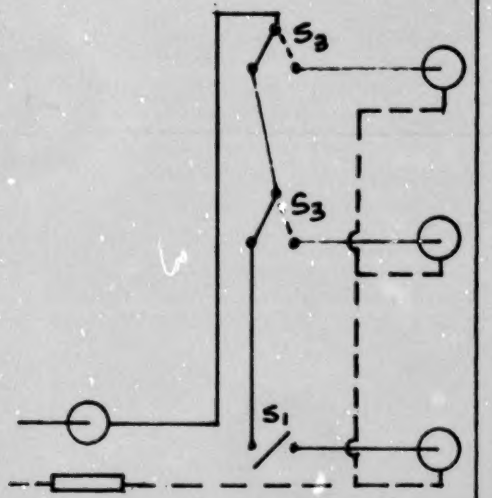
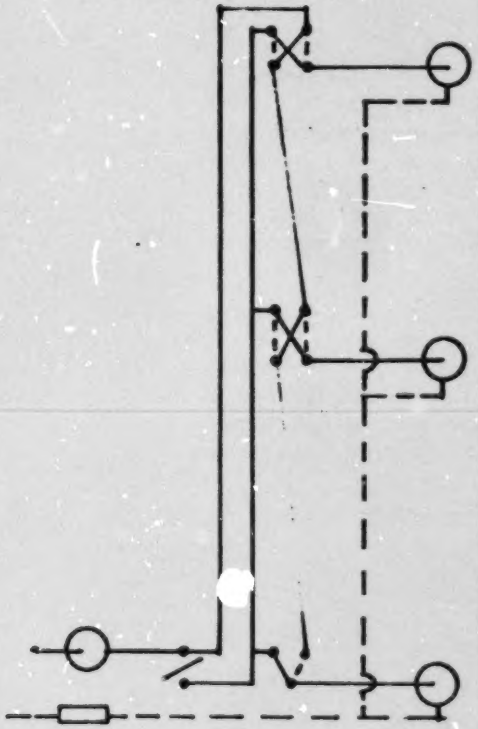
Tasks	TEACHING CONTENT: Development of Skills	TEACHING CONTENT: Development of Related Information
18. Install a progressive lighting system with three lighting outlets controlled by a single pole switch and two three-way switches so that: Sw. #1 on = Light 1 on, 2 and 3 off; Sw. #1 and Sw. #2 on - Light 2 on, 1 and 3 off. Sw. #1, Sw. #2, Sw. #3 on - Light 3 on, 1 and 2 off. Operate switches sequentially in reverse order to de-energize entire circuit.  117 Fig. #10	A. Develop job circuit on chalkboard. (See Fig. #10) B. Demonstrate how true offsets of any rise may be formed on E.M.T. using a bender. C. Review mounting of equipment. D. Review job circuit wiring. E. Test for proper operation at each switch.	Discuss conductor application and insulations (N.E.C., Article 310) 1. Trade name 2. Type letter 3. Maximum operating temperature 4. Application provisions 5. Insulation 6. Gauge 7. Outer covering

19. Install a progressive lighting system using one three-way, and two four-way, and one single pole master which will turn on all three lights regardless of the position of the other switches.



119 Fig. #11

A. Develop job circuit on chalkboard. (Fig. #11).
B. Describe and illustrate special purpose for circuit.
C. Demonstrate how to complete bends on E.M.T. to an exact point.
D. Review mounting of equipment.
E. Review job wiring procedures.
F. Test for proper operation.

Discuss circular and square mils.
1. Meaning of circular mil
2. Meaning of square mil
3. Calculating for circular mils of round wire
4. Calculating cross-sectional area of square and rectangular wires.
5. Working out examples.

Tasks	Development of Skills	Development of Related Information
20. Install an outlet, controlled by a single pole switch and a separate pilot light to indicate when outlet is live.	A. Develop job circuit on chalkboard. B. Review uses and circuitry for pilot lights. C. Review mounting of equipment. D. Review job wiring procedures. E. Test for proper operation.	Discuss bending large sizes of E.M.T. 1. Hydraulic bender construction and operation 2. Use of chart 3. Setting up for bending 4. Bending procedure
21. Install a lighting outlet controlled by a single pole switch and a separate pilot light to indicate when main light is "off".	A. Develop job circuit on chalkboard. (See Fig. #12). B. Illustrate jumping switch as a troubleshooting technique for an open circuit. C. Review mounting of equipment. D. Review job wiring procedures. E. Test for proper operation.	Discuss code regulations for dimensions of rubber-covered and thermoplastic-covered conductors (N.E.C. - Chapter 9, Table 5). 1. Diameter in inches 2. Area in square inches

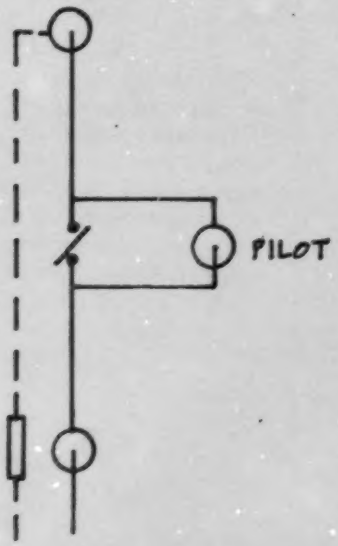
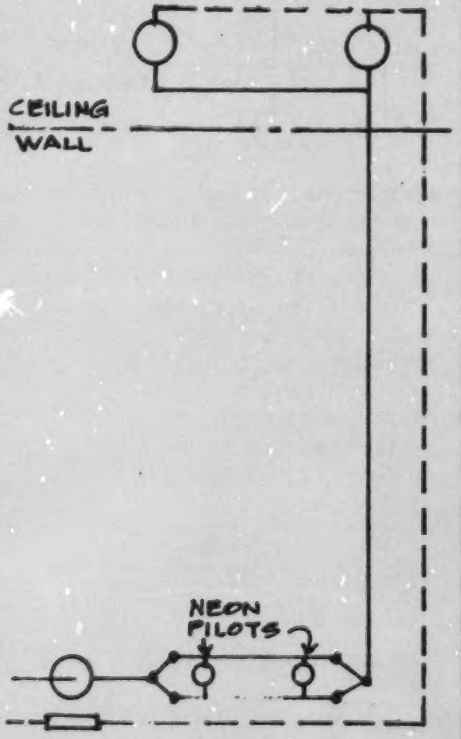


Fig. #12

22. Install two ceiling outlets simultaneously controlled from either of two locations with neon lights at each three way switch to indicate when the outlets are de-energized.



123 Fig. #13

A. Develop job circuit on chalkboard. (See Fig. #13).
B. Review mounting of equipment.
C. Review job wiring procedures.
D. Test for proper operation from switches and neons.

Discuss properties of conductors (N.E.C. - Chapter 9, Table 8)
1. Sizes
2. Diameter
3. Area
4. D.C. Resistance

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Tasks	TEACHING CONTENT: Development of Skills	TEACHING CONTENT: Development of Related Information
23. Install two ceiling outlets, simultaneously controlled from either of two locations and a master switch located between the 2 three-way switches. Wire the master across the travelers and use a 3 point saddle bewteen any two of the switches.	A. Develop job circuit on chalkboard. (See Fig. #14). B. Illustrate special type of mastering used. C. Relate this circuit to pilot circuit. D. Review mounting of equipment. E. Review job circuit wiring F. Test for proper operation.	Discuss the power formula and calculate costs for operating various equipment. 1. Formula: P = E x I 2. Converting watts to kilowatts 3. Multiplying kilowatts by cost per kilowatt

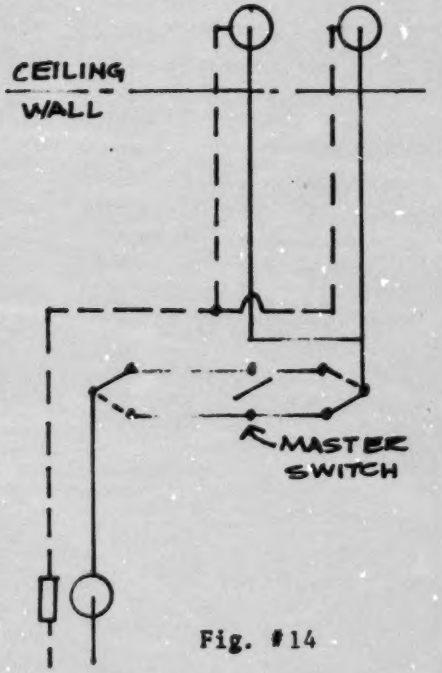

Fig. #14

24. Install an alternate control lighting system using two lighting outlets, two four-way, and one three-way switch, whereby any switch will turn one light on and the other off alternately, and one light is always on.

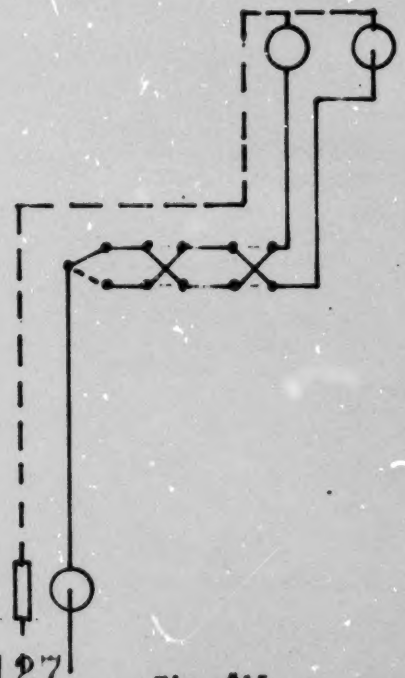

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Fig. #15

A. Develop job circuit on chalkboard. (See Fig. #15).
B. Illustrate wiring of special alternate control.
C. Relate to traffic light circuit.
D. Review mounting of equipment.
E. Review job wiring procedures.
F. Test for proper operation at each switch.

Discuss feeder calcuations for a single family dwelling (N.E.C. - Chapter 9, Example 1)

1. Computed load
2. Minimum number branch circuits
3. Minimum size feeders required
4. Feeder and service neutral

Tasks	TEACHING CONTENT	
	Development of Skills	Development of Related Information
25. Install a stagger lighting system of four outlets controlled from ganged single pole switches. Sw. #1 controls lights 1 and 3. Sw. #2 controls lights 2 and 4.	A. Develop job circuit on chalkboard. B. Discuss application for this circuit. C. Review installation of two ganged boxes. D. Review mounting of equipment. E. Review job wiring procedures. F. Test for proper operation.	Discuss feeder calcuations for single family dwelling (N.E.C. - Table 9, Example 1 B). 1. Computing lighting and air conditioning loads 2. Branch circuit load 3. Net computed load 4. Feeder neutral load
26. Install a four circuit fuse panel utilizing two circuits, whereby circuit #1 is for two convenience outlets and circuit #2 is for the switch-controlled ceiling outlet.	A. Develop job circuit on chalkboard. B. Review construction and internal circuitry of four-circuit fuse panels. C. Demonstrate mounting of four-circuit fuse panel. D. Review job wiring procedures. E. Test for proper operation of each circuit.	Discuss feeder calcuations for a road-side fruit stand (N.E.C. - Chapter 9, Example 2). 1. Computed load 2. Minimum size service conductors

27. Install a four circuit fuse panel utilizing all four circuits, wherein circuits #1 and #2 are for the kitchen appliances and circuits #3 and #4 are for a 208V air conditioner.

A. Develop job circuit on chalkboard.
B. Review connection of 208 volts air conditioner.
C. Review mounting of equipment.
D. Review job wiring procedures.
E. Test for proper operation of 120 volts and 208 volts circuits.

Discuss feeder calcuations for a store building.
1. Computed load
2. Minimum number of branch circuits
3. Minimum size feeders

28. Install a circuit breaker panel utilizing two circuits, wherein circuit #1 is for two conveniece outlets and circuit #2 is for a switched ceiling outlet.

A. Develop job circuit on chalkboard.
B. Review construction and internal circuitry of circuit breaker panels.
C. Demonstrate mounting of the circuit breaker panel.
D. Review job wiring procedures.
E. Test for proper operation.

Discuss feeder calcuations for a multi-family dwelling (N.E.C. - Chapter 9, Example 4).
1. Computed load for each dwelling
2. Minimum number branch circuits for each dwelling.
3. Minimum size subfeeder for each dwelling
4. Minimum size feeders from service to meter bank
5. Minimum size main feeder required

Tasks	TEACHING CONTENT	
	Development of Skills	Development of Related Information
29. Install a circuit breaker panel utilizing four circuits, wherein circuit #1 is for house lighting, circuit #2 is for convenience outlets, and circuits #3 and #4 are for a 208V air conditioner.	A. Develop job circuit on chalkboard. B. Review circuit breaker panel connections for 120 volts and 208 volts. C. Review job mounting procedures. D. Review job wiring procedures. E. Test for proper operation.	Discuss code regulations for appliances. (N.E.C. - Article 422) 1. Branch circuit requirements 2. Installation 3. Control and protection 4. Marking
30. Install a circuit breaker panel utilizing six circuits, wherein circuits #1 and #2 are for house lighting, circuits #2 and #4 are for kitchen appliance outlets, and circuits #5 and #6 are for a 208V air conditioner.	A. Develop job circuit on chalkboard. B. Review advantages of circuit breakers. C. Review types and operation of breakers. D. Review installation of single and double breakers. E. Review job wiring procedures. F. Test for proper operation of each circuit.	Review unit on E.M.T. Installations 1. Code regulations 2. Type bends used 3. Wiring in E.M.T. 4. Fittings and boxes

Unit IV: Services and Meters

Level Two: Lighting
Suggested Time: *20 Hours / 30 Periods*

Performance Objectives

Upon completion of Unit IV student will be able to:

- Install a three-wire overhead, 120/208V single-phase service. Include a meter pan and a distribution panel with built in main switch.
- Install a three-wire overhead 120/280V single phase service utilizing six circuits. Include a meter pan and a distribution panel with a built in main switch.
- Install a three-phase four-wire, 200 ampere service utilizing a meter pan, a current transformer cabinet, and a distribution panel with main disconnect. Wire job for six circuits, one of which is to be a three-phase outlet.

Tasks	TEACHING CONTENT	
	Development of Skills	Development of Related Information
1. Install a three-wire overhead, 120/208V. single phase overhead service with a meter socket, service switch, and a four circuit panel. Wire job utilizing all four branch circuits.	A. Demonstrate 1. Mounting service equipment 2. Installing weather head 3. Installing service conduit 4. Installing 5 jaw meter pan 5. Installing and connecting service switch 6. Installing and connecting distribution panel 7. Installing service ground 8. Terminating service conductors B. Wire branch circuits to plan provided by instructor C. Test job for proper operation.	A. Discuss preparing a bill of materials 1. Reading of meter specifications 2. Taking material "off" specifications. 3. Ordering meter equipment 4. Measuring and laying out meter equipment B. Discuss service entrance 1. Service drop-up 2. Conductors 3. Conduit 4. Meter pan 5. Disconnectiong means 6. Grounding C. Discuss fastening equipment on 1. Brick 2. Concrete 3. Wood D. Discuss code regulations for service clearance (N.E.C., Article 230) 1. Driveways 2. Porches 3. Windows 4. Roofs 5. Streets

2. Install a three wire, overhead, 120/208V single phase service. Include a meter pan and a distribution panel with a built-in main switch. Wire job utilizing four circuits.	A. Review all skills performed in Job #1. B. Demonstrate hook-up of built-in main switch and distribution panel. C. Wire branch circuits to plan provided by instructor. D. Test job for proper operation.	Discuss standard voltage distribution systems. 1. 1 phase, 120 volts 2. 1 phase, 120/240 volts 3. 1 phase, 120/208 volts 4. 3 phase, 4 wire WYE 5. 3 phase, 4 wire DELTA
3. Install a three wire, overhead, 120/208V single phase service. Include a meter pan, a distribution panel with a built in main switch, and a four circuit sub panel. Wire job utilizing two circuits from each panel.	A. Review all skills performed in Jobs #1 and #2. B. Demonstrate installation of sub-panel and wiring procedure. C. Demonstrate wiring of branch circuits according to plan provided by instructor. D. Test job for proper operation.	A. Discuss watt-hour meters 1. Types 2. Purpose 3. Construction 4. How to read 5. Location 6. Applications B. Discuss code regulations for services (N.E.C., Article 230) 1. Insulation and size of service conductors 2. Overhead services 3. Service entrance conductors

Tasks	TEACHING CONTENT	
	Development of Skills	Development of Related Information
4. Install a three-wire overhead 120/208V single phase service. Include a meter pan and a 12 circuit combination main breaker panel. Wire job utilizing six circuits.	A. Review all skills performed in Jobs #1, #2, and #3 B. Demonstrate mounting of 12 circuit combination main breaker panel. C. Wire job according to plan provided by instructor. D. Test job for proper operation.	A. Discuss code regulations for services (N.E.C., Article 230) 1. Installation of service conductors 2. Guarding and grounding 3. Overcurrent protection 4. Services exceeding 600 volts, nominal
5. Install a three-phase underground four-wire, 100 Ampere service utilizing a meter socket, and a distribution panel with a built in main switch. Wire job for six circuits, one of which is a three-phase receptacle.	A. Demonstrate 1. Mounting service equipment 2. Installing meter socket 3. Installing distribution panel 4. Sealing underground holes. 5. Installing service ground B. Demonstrate wiring branch circuits to plan provided by instructor. 1. 5 single phase 2. 1 three phase C. Test job for proper operation.	A. Discuss underground services 1. Advantages and disadvantages compared to overhead type. 2. Responsibility of utility and customer. B. Discuss code regulations for underground services (N.E.C., Article 230). C. Discuss the three-phase, four-wire service 1. WYE and DELTA 2. Circuitry 3. Advantages 4. Voltages available 5. Grounding

6. Install a three-phase, four-wire, 200 Ampere service utilizing a meter pan, a current transformer cabinet, and a distribution panel with a main disconnect.
Wire job for six circuits, one of which is to be a three phase outlet.

A. Review indoor service skills performed in Job #5.
B. Demonstrate installation and hook-up of current transformer cabinet.
C. Demonstrate wiring branch circuits to plan provided by instructor.
D. Test job for proper operation.

A. Discuss current transformers
    1. Purpose
    2. Construction
    3. Principle of operation
    4. Ratio
    5. Safety
B. Phase sequence of three phase systems
    1. Polarity
    2. Color code

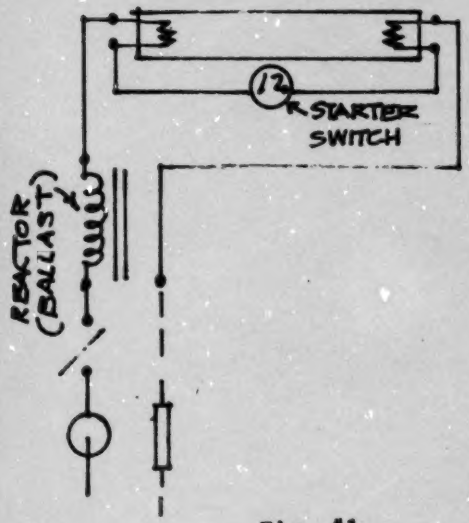
Unit V: Fluorescent Lighting

Level Two: Lighting
Suggested Time: *20 Hours / 30 Periods*

Performance Objectives

Upon completion of Unit V student will be able to:

- Wire a single lamp, 20 watt, pre-heated fluorescent fixture.
- Wire a two-lamp, 20 watt, pre-heated fluorescent fixture with a control circuit and a two circuit switch.
- Wire a four lamp, 40 watt, rapid start fixture using two ballasts with power factor correction.

Tasks	TEACHING CONTENT: Development of Skills	TEACHING CONTENT: Development of Related Information
1. Wire a single lamp, 20 watt, pre-heat fluorescent fixture.  Fig. #1	A. Develop job circuit on chalkboard. (Fig. #1). 1. Describe the basic preheat circuit. 2. Explain why the simple reactor-type ballast is used on this job. 3. Explain function of each part in the circuit. B. Demonstrate how to mount the fixture. C. Demonstrate job wiring procedures for fluorescents. D. Test for proper operation.	Discuss fluorescent lighting. 1. Definition 2. Principle of operation 3. Advantages over incandescent lighting. 4. Applications
2. Wire a two-lamp, 20 watt pre-heat, fluorescent fixture using two ballasts; control circuit with two circuit switch.	A. Develop job circuit on chalkboard. 1. Discuss reason for two ballasts. 2. Describe action of two circuit switch in circuit. B. Demonstrate mounting of two lamp fixture. C. Demonstrate job wiring procedures. D. Test for proper operation.	A. Discuss the fluorescent lamp 1. Construction 2. Principle of operation 3. Relate size to voltage required B. Discuss the fluorescent ballast 1. Basic construction 2. Principle of operation 3. Function in the circuit 4. Ballast-voltage ratio

3. Wire a three-lamp, 20 watt pre-heat fixture, using one double ballast for two lamps and a separate ballast for the third lamp; control circuit with two circuit switch.

A. Develop job circuit on chalkboard.
   1. Describe lighting sequence obtained with switch.
B. Demonstrate mounting of the three lamp fixture.
C. Demonstrate job wiring procedures.
D. Test for proper operation.

A. Discuss the starter used in preheat fixtures.
   1. Construction
   2. Principle of operation
   3. Action in a circuit
B. Discuss the reactor-type ballast
   1. Construction
   2. Principle of operation
   3. Action in a circuit.

	TEACHING CONTENT	
Tasks	Development of Skills	Development of Related Information
4. Wire a single lamp, 32 watt, preheat circline fixture.	A. Develop job circuit on chalkboard. (See Fig. #2) 1. Describe the circline single lamp circuit. B. Demonstrate mounting of circline fixtures. C. Demonstrate job wiring procedures. D. Test for proper operation.	A. Discuss circline fixtures 1. Basic circuitry 2. Applications B. Discuss fluorescent dimming 1. Principle of operation 2. Special ballasts required 3. Dimmer adjustment

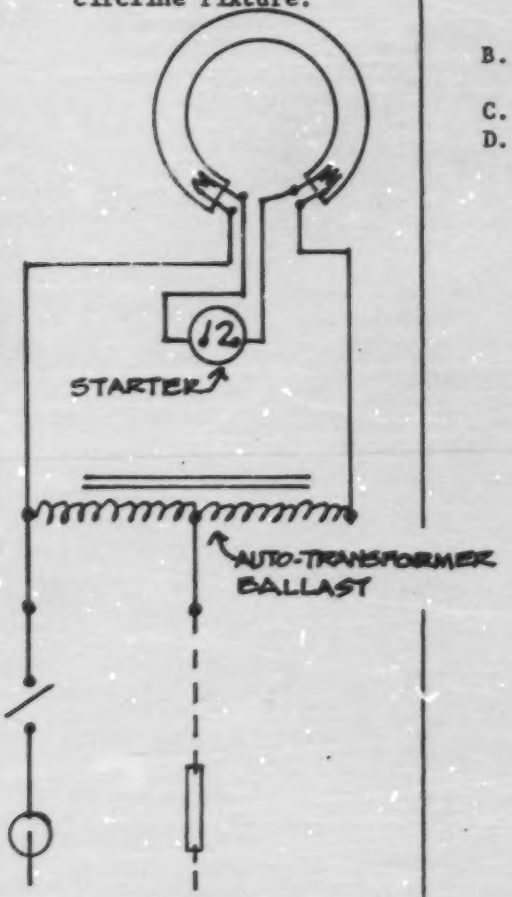


Fig. #2

5. Wire a two-lamp, 22 watt, and 32 watt, pre-heat, circline fixture; control circuit with a two circuit switch.	A. Develop job circuit on chalkboard. 1. Describe operation of two lamp circline fixture. 2. Demonstrate action of two circuit switch. B. Demonstrate mounting of two lamp circline fixture. C. Review job wiring procedures. D. Test job for proper operation.	Discuss code regulations for fluorescent lighting fixtures. (N.E.C., Articles 210, 380, 410) 1. Lamp terminals 2. Voltages - dwellings 3. Fixture mounting 4. Auxiliary equipment 5. Auto-transformers 6. Snap switches 7. Circuit ratings 8. Connections 9. Ballast protection
6. Wire a single lamp, 40 watt, pre-heat fluorescent fixture.	A. Develop job circuit on chalkboard. 1. Describe action of auto-transformer type ballast in this circuit. 2. Review principle of operation for pre-heat fixtures. B. Demonstrate mounting of a 40 Watt fluorescent fixture. C. Review job wiring procedures. D. Test for proper operation.	A. Discuss the auto-transformer type ballast. 1. Purpose 2. Construction 3. Principle of operation 4. Action in a circuit B. Discuss code regulations for fixtures as raceways (N.E.C., Article 410).

Tasks	TEACHING CONTENT: Development of Skills	TEACHING CONTENT: Development of Related Information
7. Wire a single lamp, 32 Watt circline fixture using a trigger start ballast.	A. Develop job circuit on chalkboard. (Fig. #3). 1. Describe action of trigger start ballast in this circuit. 2. Illustrate circuit operation without starter. B. Demonstrate mounting of fixture. C. Review job wiring procedures. D. Test for proper operation.	A. Discuss fluorescent lamp types 1. Pre-heat 2. Instant start 3. Rapid start B. Discuss the trigger start type ballast 1. Construction 2. Principle of operation 3. Action in a circuit

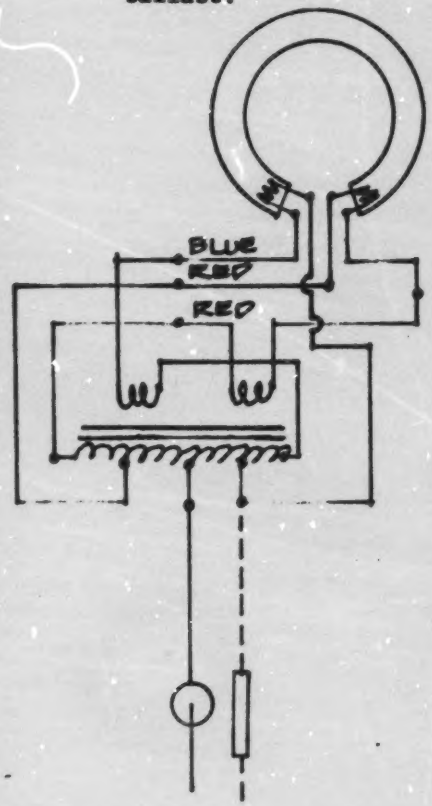


Fig. #3

8. Wire a two-lamp, 40 watt, rapid start fixture; use two circuit switch for control of lamps.	A. Develop job circuit on chalkboard. 1. Describe circuitry and operation of rapid start ballast in this circuit. B. Demonstrate mounting of the fixture. C. Review job wiring procedures. D. Test for proper operation.	A. Discuss rapid start ballasts. 1. Construction 2. Principle of operation 3. Advantage 4. Action in a circuit 5. Types of lamps required B. Discuss factors affecting ballast life 1. Applied voltage 2. Lamp maintenance 3. Ventilation
9. Wire a four-lamp, 40 watt, rapid start fixture using two ballasts with power factor correction; control lamps with a two circuit switch.	A. Develop job circuit on chalkboard. 1. Describe power factor correction and how it is obtained in the circuit. 2. Review type of circuitry used. B. Demonstrate mounting of a four-lamp fixture. C. Review job wiring procedures. D. Test for proper operation.	A. Discuss instant start ballasts 1. Construction 2. Principle of operation 3. Action in a circuit 4. Types of circuits 5. Lamp requirements B. Discuss lighting design for a room 1. Lighting intensity 2. Type of lighting 3. Lamp colors 4. Reflectors 5. Wall colors 6. Spacing

Tasks	TEACHING CONTENT	
	Development of Skills	Development of Related Information
10. Wire a two-lamp, 96 inch, instant start, single pin fixture.	A. Develop job circuit on chalkboard. B. Demonstrate troubleshooting procedures on prefaulted fixtures arranged for this purpose. C. Demonstrate mounting of eight-foot fixture. D. Review job wiring procedures. E. Test for proper operation.	A. Discuss troubleshooting procedures used on fluorescent fixtures. 1. Checking the lamp 2. Checking a starter 3. Checking for poor lamp contact 4. Checking for low line voltage 5. Checking the ballast B. Discuss fluorescent lamps 1. Number of pins required 2. Filament construction requirements 3. Shapes 4. Colors 5. Lamp cleaning

Unit VI: Metal Molding

Level Two: Lighting
Suggested Time: *20 Hours / 30 Periods*

Performance Objectives

Upon completion of Unit VI student will be able to:

- Cut to measurement, de-burr, and assemble metal molding.
- Install two ceiling outlets controlled by a single pole switch; use a flat tee between outlets, an internal elbow, and a flat elbow.
- Bend an elbow on metal molding.

Tasks	TEACHING CONTENT	
	Development of Skills	Development of Related Information
1. Cut to measurement, de-burr, and assemble metal molding.	Demonstrate 1. Measurement of lengths to be cut 2. Cutting metal molding with hacksaw 3. Cutting metal molding with shears 4. De-burring of metal molding 5. Assembling of backing and capping	Discuss metal molding applications Discuss cutting metal molding 1. Hand hacksaw and blade 2. Molding shears 3. Cutting and notching gauge Discuss safety in cutting and de-burring metal molding
2. Install one outlet, controlled by a single pole switch, and a live convenience outlet	A. Develop job circuit on chalkboard B. Demonstrate 1. Cutting and de-burring of metal molding needed for all runs 2. Installing metal molding boxes. 3. Installing backing for all runs. 4. Laying in conductors and snapping on capping. 5. Installing outlet covers 6. Connecting and installing devices according to job circuit C. Test job for proper operation.	

3. Install two outlets, simultaneously controlled from either of two locations

A. Develop job circuit on chalkboard
B. Review operation and circuitry of three way switches.
C. Review installation of metal molding systems.
D. Review job wiring procedures.
E. Test job for proper operation.

4. Install two ceiling outlets, whereby one is controlled by a single pole switch and the other is live; use an internal elbow in the raceway from wall to ceiling

A. Develop job circuit on chalkboard.
B. Demonstrate installation of internal elbow (See Fig. #1.)
C. Review installation of metal molding.
D. Review job wiring procedures.
E. Test for proper operation.

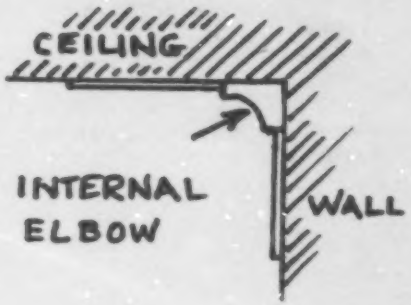
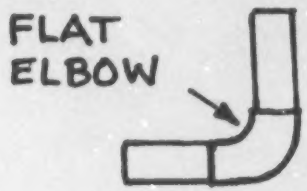


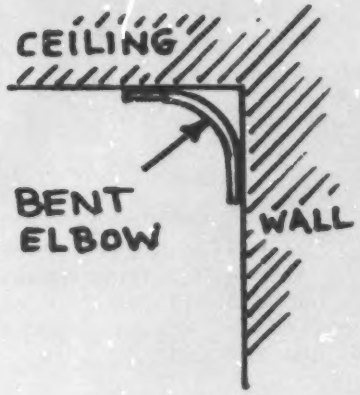
Fig. #1

A. Discuss Code regulations for metal molding (N.E.C., Article 352)
   1. Permitted locations
   2. Prohibited locations
   3. Conductor sizes
   4. Number of conductors in raceways
B. Discuss metal molding fittings
   1. Types
   2. Installation
   3. Locations

A. Discuss code regulations for metal molding (N.E.C., Artcle 352)
   1. Extension through walls and floors
   2. Combination raceways
   3. Splices and taps
   4. Construction
B. Discuss internal and external elbows.
   1. Use
   2. Cutting and notching base
   3. Capping

Tasks	TEACHING CONTENT: Development of Skills	TEACHING CONTENT: Development of Related Information
5. Install two ceiling outlets controlled by a double pole switch, and a live convenience outlet; use a flat elbow and an internal elbow.  Fig. #2	A. Develop job circuit on chalkboard. B. Review operation and circuitry of double pole switches. C. Describe the need for a flat elbow and demonstrate how it is installed. (See Fig. #2) D. Review mounting of all equipment. E. Review job wiring procedures F. Test job for proper operation.	A. Discuss use of metal molding catalog. 1. Identifying fittings 2. Ordering fittings B. Discuss Whitney Punch for punching holes in metal molding 1. Construction 2. Use 3. Safety
6. Install two ceiling outlets controlled by a single pole switch; use a flat tee between outlets, an internal elbow, and a flat elbow. Fig. #3	A. Develop job circuit on chalkboard. B. Describe the need for a flat tee and demonstrate how it is installed. (See Fig. #3) C. Review installation of metal molding including flat and internal elbows. D. Review job wiring procedures. E. Test for proper operation.	A. Discuss wire fills for metal molding (Sizes #111, #333, #888, #1700) B. Discuss the cutting and matching gauge 1. Construction 2. Applications 3. Operation

7. Bend an elbow on metal molding.



(Fig. #4)

A. Describe the need for an elbow and illustrate how it is used.(See Fig.#4).
B. Demonstrate
   1. Determining the elbow size required
   2. Attachment of back and cap.
   3. Placing metal molding in the bending tool.
   4. Bending the elbow.
   5. Checking the elbow for dimension and alignment.

A. Discuss the metal molding bending tool
   1. Construction
   2. Use
   3. Safety
B. Safety procedures
   1. Separating an accident victim from power
   2. Administering mouth-to-mouth resuscitation
   3. Treating electrical burns
   4. Checking victim's pulse

8. Bend an offset on metal molding

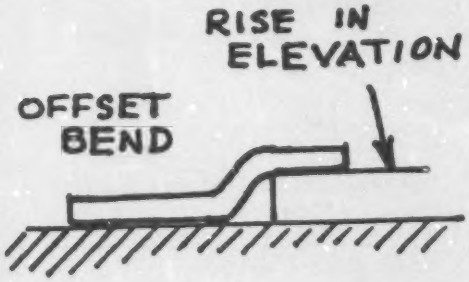


Fig. #5

A. Describe the use of offsets to meet changes in elevation (Fig. #5)
B. Demonstrate
   1. Measuring the rise for an offset
   2. Determining molding bending marks
   3. Placing molding in the bending tool
   4. Performing the bend
   5. Checking the offset for dimension and alignment

A. Discuss adapter fittings used to couple metal molding with other types of raceways.
B. Discuss and compare types of bends made on metal molding
   1. Elbows
   2. Offsets
   3. Saddles

Tasks	TEACHING CONTENT	
	Development of Skills	Development of Related Information
9. Install a ceiling outlet, controlled by a single pole switch, and a live convenience outlet; use a bend elbow.	A. Develop job circuit on chalkboard B. Demonstrate installation of bent elbow C. Review mounting of equipment. D. Review job wiring procedures. E. Test job for proper operation.	Discuss plug fuses (N.E.C., Article 240) 1. Construction 2. Maximum voltage 3. Marking 4. Edison base type 5. Type S Fuses 6. Type S Adapters
10. Install two ceiling outlets, simultaneously controlled from any of three locations; a bent elbow at corner and an offset between outlets.	A. Develop job circuit on chalkboard B. Review operation and circuitry of four way switches C. Review three location control of lights D. Review job mounting procedures. Install bent elbow and offset. E. Review job wiring procedures F. Test job for proper operation.	Review metal molding 1. Applications 2. Code regulations 3. Job opportunities 4. Installation 5. Bends 6. Tools used 7. Boxes and fittings 8. Safety

Unit VII: Wiremold

Level Two: Lighting
Suggested Time: *20 Hours / 30 Periods*

Performance Objectives

Upon completion of Unit VII student will be able to:

- Cut to measurement and de-burr wiremold.
- Install two ceiling outlets, controlled by a double pole switch and a line convenience outlet using a bent elbow and a flat elbow on ceiling.
- Install three ceiling outlets, controlled individually from three switches, with each light selectively mastered from a central station.

Tasks	TEACHING CONTENT	
	Development of Skills	Development of Related Information
1. Cut to measurement and de-burr wiremold.	Demonstrate 1. Measurement of lengths to be cut. 2. Cutting wiremold with hacksaw in cutting box. 3. De-burring of wiremold.	A. Discuss wiremold applications. B. Discuss cutting wiremold 1. Hand hacksaw and blade 2. Cutting and notching gauge 3. Compare to metal molding C. Discuss safety in cutting and de-burring wiremold.
2. Install two wall outlets controlled by a single pole switch, with a live convenience outlet.	A. Develop job circuit on chalkboard. B. Demonstrate 1. Cutting and de-burring of wiremold needed for all runs 2. Installing wiremold boxes 3. Installing all wiremolds runs 4. Wiring in wiremold 5. Installing covers C. Test job for proper operation	A. Discuss wiremold 1. Sizes 2. Installation 3. Method of wiring with comparison to metal molding B. Discuss job opportunities 1. Communication industry 2. Office alterations

3. Install two ceiling outlets, one controlled by a single pole switch and the other to be live. Include a live convenience receptacle. Use an internal elbow.	A. Develop job circuit on chalkboard B. Review installation of wire mold systems C. Demonstrate installation of internal elbow. D. Review job wiring procedure E. Test job for proper operation.	A. Discuss code regulations for wiremold (N.E.C., Article 352) 1. Permitted locations 2. Prohibited locations 3. Conductor sizes 4. Number of conductors in raceways B. Discuss wiremold fittings 1. Types 2. Installation 3. Location
4. Bend an elbow on wiremold	A. Describe the need for elbows and illustrate how they are used. B. Demonstrate 1. Determining elbow size 2. Placing wiremold in bender. 3. Bending the elbow 4. Checking the elbow for dimension and alignment	A. Discuss code regulations for wiremold (N.E.C., Article 352) 1. Extension through walls and floors 2. Combination raceways 3. Splices and taps 4. Construction B. Discuss the wiremold bender 1. Construction 2. Use 3. Safety

Tasks	TEACHING CONTENT	
	Development of Skills	Development of Related Information
5. Install two ceiling outlets, controlled by a double pole switch, and a live convenience outlet; use a bent elbow and a flat elbow on ceiling.	A. Develop job circuit on chalkboard. B. Review use and circuitry for double pole switches. C. Review installation of wiremold systems. Demonstrate installation of bent and flat elbows. D. Review job wiring procedures. E. Test job for proper operation.	A. Discuss the use of the wiremold catalog. 1. Identifying fittings 2. Ordering fittings B. Discuss wire fills for wiremold (Sizes # 500, #700, #1500, #2000)
6. Bend an offset on wiremold.	A. Describe the use of offsets to meet changes in elevation B. Demonstrate 1. Measuring for rise of offset. 2. Determining bending marks. 3. Performing the offset bend 4. Checking saddle for dimension and alignment.	A. Discuss adapter fittings used to couple wiremold with other types raceway. B. Discuss and compare types of bends made on wiremold 1. Elbows 2. Offsets 3. Saddles

7. Install two ceiling outlets, controlled simultaneously from two locations; use an offset between outlets.	A. Develop job circuit on chalkboard. B. Review use and circuitry for three-way switches. C. Review mounting of equipment. D. Demonstrate installation of offset. E. Review job wiring procedures. F. Test job for proper operation.	A. Discuss use of fish tape leader for pulling conductors in wiremold. B. Discuss use of wire pulley for pulling conductors. C. Discuss use of flexible sections for getting around offsets, bends, twists, turns.
8. Install a traffic signal mounted on a wall; use a flat tee between outlets and a three-way switch to achieve alternate control.	A. Develop job circuit on chalkboard. B. Review the traffic signal circuit. C. Review mounting of equipment. D. Demonstrate installation of a flat tee. E. Review job wiring procedures. F. Test jor for proper operation.	A. Discuss wiremold cutting box 1. Construction 2. Straight cuts 3. Mitering cuts 4. Hacksaw blade size used B. Discuss adequate wiring of old installations and use of surface metal raceways.

Tasks	TEACHING CONTENT	
	Development of Skills	Development of Related Information
9. Install a ceiling outlet controlled from three locations; use an internal elbow.	A. Develop job circuit on chalkboard B. Review circuitry for three location control of lights. C. Review mounting of equipment. D. Review job wiring procedures. E. Test job for proper operation.	Discuss mounting of electric equipment 1. Masonry 2. Concrete 3. Plaster partitions a. wood lath b. wire lath c. plaster board 4. Hollow tile partitions 5. Related tools, devices, and safety
10. Install two ceiling outlets controlled by separate single pole switches; use an internal elbow and a bent elbow.	A. Develop job circuit on chalkboard. B. Review mounting of equipment. C. Review job wiring procedures D. Test job for proper operation.	Review wiremold 1. Applications 2. Code regulations 3. Job opportunities 4. Installation 5. Bends 6. Tools used 7. Boxes and fittings 8. Safety

Unit VIII: Romex

Level Two: Lighting
Suggested Time: *10 Hours / 15 Period*

Performance Objective.

Upon completion of Unit VIII student will be able to:

- Install a stagger lighting system using four lights controlled from two ganged single-pole switches; switch #1 energizes lamps #1 and #3 and switch #2 energizes lamps #2 and #4.
- Install three ceiling outlets using three-way switches wired so that any one or any two lights can go on, but all three lights cannot go on.

Tasks	TEACHING CONTENT: Development of Skills	TEACHING CONTENT: Development of Related Information
1. Cut, strip, fasten, and terminate ("Romex").	A. Describe Romex installations and display typical runs. B. Display roll of Romex and describe its construction C. Demonstrate 1. Cutting Romex with pliers and stripping outer sheath with stripping tool. 2. Fastening Romex with staples 3. Terminating Romex with connectors	A. Discuss Romex (N.E.C., Article 336) 1. Definition 2. Construction 3. Permitted locations 4. Prohibited locations B. Discuss cutting and stripping Romex 1. Use of pliers 2. Use of stripping tool 3. Safety
2. Install two ceiling outlets controlled simultaneously from two locations, and a live convenience receptacle.	A. Develop job circuit on chalkboard. B. Review operation of three way switches and two location control of lights. C. Demonstrate installation of Romex in a lighting system. 1. Cutting 2. Stripping 3. Fastening 4. Terminating D. Review job connection procedures E. Test job for proper operation.	Discuss Romex (N.E.C., Article 336) 1. Marking 2. Supporting cable 3. Exposed work 4. Protection from physical damage

3. Install a stagger lighting system using four lights controlled from two ganged single pole switches, whereby switch #1 energizes lamps #1 and 3, and switch #2 energizes lamps #2 and #4.

A. Develop job circuit on chalkboard.
B. Review stagger lighting.
C. Demonstrate job mounting procedures including installation of ganged boxes
D. Review job wiring procedures
E. Test job for proper operation.

4. Install three ceiling outlets using three three-way switches wired so that any one or any two lights can go on, but all three lights cannot go on.

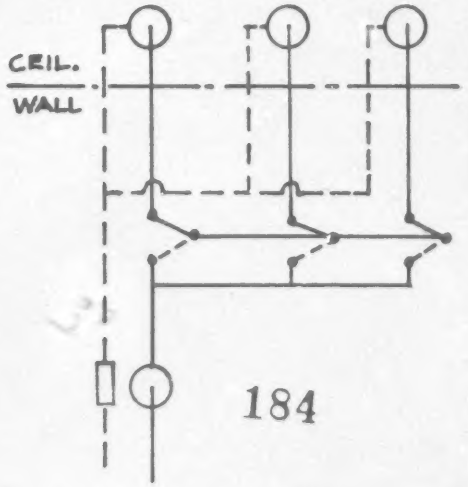


Fig. #1

A. Develop job circuit on chalkboard. (Fig. #1).
B. Review the special lighting circuit required.
C. Review mounting of equipment.
D. Review job wiring procedures
E. Test job for proper operation.

Discuss Romex (N.E.C., Article 336)
1. In unfinished basements
2. In accessible attics
3. Bends in Romex
4. Devices of insulating materials

A. Discuss insulation color code for cable.
1. Two-conductor - white, black, and a grounding wire
2. Three-conductor - white, black, red, and a grounding wire
3. Four-conductor - white, black, red, blue and a grounding wire
4. Five-conductor - white, black, red, blue, yellow, and grounding wire
5. Four and five wire cable are available, but rarely used in house wiring
6. The grounding wire is usually a bare wire, but it may have a green or green with yellow stripe insulation

Unit IX: Low-Voltage Remote Control

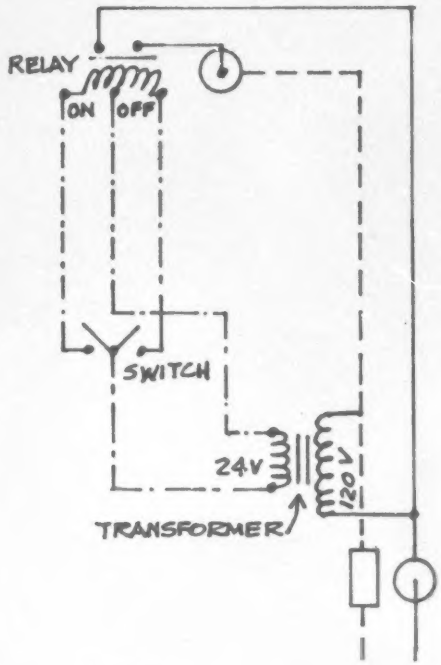
Level Two: Lighting
Suggested Time: ***10 Hours / 15 Periods***

Performance Objectives

Upon completion of Unit IX student will be able to:

- Install one ceiling outlet controlled by one low-voltage switch.
- Install one ceiling outlet, controlled from two locations, with a remote master.
- Install three ceiling outlets, controlled individually from three switches, with each light selectively mastered from a central station.

TEACHING CONTENT		
Tasks	Development of Skills	Development of Related Information
1. Install one ceiling outlet controlled by one low-voltage switch.	A. Develop job circuit on chalkboard. (See Fig. #1) B. Demonstrate operation of the relay and switch. C. Demonstrate mounting of equipment. D. Demonstrate wiring and connecting of circuit. 1. 120 volts side 2. 24 volts side E. Test job for proper operation.	A. Discuss low-voltage remote control systems. 1. Types 2. Principle of operation 3. Voltage of systems B. Low voltage relays 1. Types 2. Principle of operation 3. Action in circuit C. Low-voltage remote control switches 1. Types 2. Switch positions 3. Action in circuit



NOTE:

———— = H.V. UNGROUND CONDUCTOR

– – – – – – = H.V. GROUNDED CONDUCTOR

——·——·—— = LOW VOLTAGE CONDUCTORS

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Fig. #1

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2. Install one ceiling outlet, controlled from two locations.

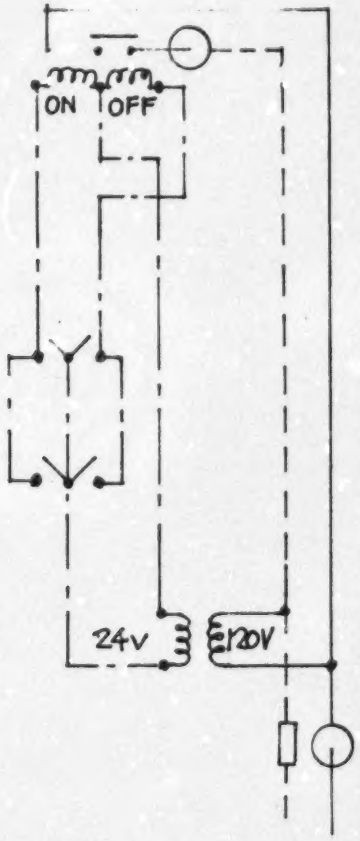

Fig. #2

A. Develop job circuit on chalkboard. (See Fig. #2)
B. Demonstrate operation of low voltage switches in parallel.
C. Review mounting of equipment.
D. Review job wiring procedures.
E. Test job for proper operation from either switch.

A. Discuss low-voltage remote control wiring methods
    1. Exposed wiring
    2. Concealed wiring
    3. Protected wiring
B. Code regulations for low-voltage remote control systems (N.E.C., Article 725)
    1. Overcurrent protection
    2. Voltage
    3. Transformer size
    4. Separation from other conductors
    5. Vertical runs
    6. Conductor insulation

Tasks	TEACHING CONTENT: Development of Skills	TEACHING CONTENT: Development of Related Information
3. Install one ceiling outlet, controlled from two locations, with a remote master.	A. Develop job circuit on chalkboard. (See Fig. #3) B. Describe and demonstrate circuitry and operation of master switch. C. Review mounting of equipment. D. Review job wiring procedures. E. Test for proper operation from individual and master switches.	A. Discuss supports for low-voltage remote control devices. 1. Switches 2. Relays 3. Methods of fastening wiring installations. B. Troubleshooting low-voltage remote control systems. 1. Supply transformer 2. Relay 3. Remote control switches 4. Wiring

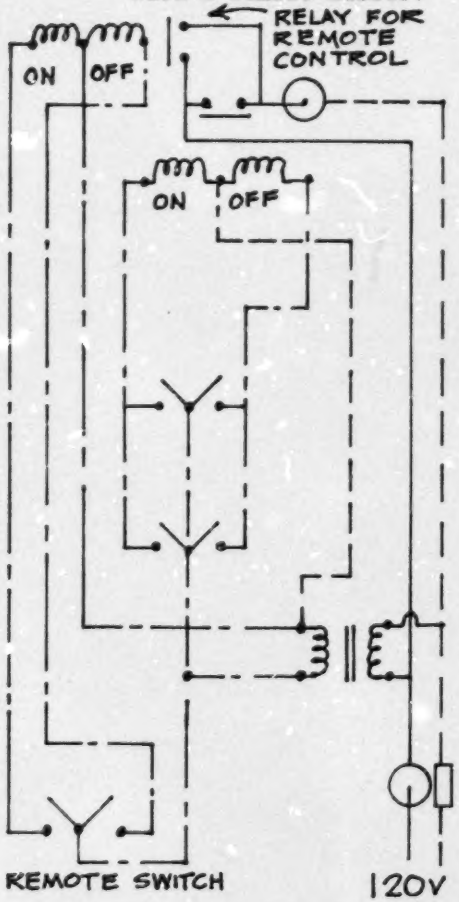

Fig. #3

4. Install three ceiling outlets, controlled individually from three switches, with each light selectively mastered from a central station.

A. Develop job circuit on chalkboard

B. Describe and demonstrate circuitry and operation of master control panel.

C. Review mounting of equipment.

D. Review job wiring procedures.

E. Test job for proper operation of individual switches and master control.

A. Discuss selector switches used in low-voltage remote control systems.
   1. Manual selector
      a. Parts
      b. Operation
      c. Use
      d. Connection into circuit
   2. Motor-operated master
      a. Parts
      b. Operation
      c. Use
      d. Connection into circuit

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Sample Lesson Plan

TOPIC Armored Cable Wiring

AIM To wire a ceiling light receptacle to be controlled by a double pole switch (S_2).

INSTRUCTIONAL OBJECTIVES

A. That students will be able to express in writing, their knowledge of the construction, circuitry and code regulations for the S_2.
B. That students will be able to wire the circuit in armored cable to required specifications so that it operates correctly without defects.

PREPARATION

A. Have working model of S_2.
B. Have demonstration circuit to show operation.
C. Have colored chalk for circuit development.
D. Have equipment layout diagram on chalkboard.

MOTIVATION Describe necessity for this switch as required by code for outdoor signs and lights, and hazardous locations.

PRESENTATION

A. Use model to depict switch internal operation.
B. Explain code regulations for S_2 circuits.
C. Develop wiring diagram, with student assistance, from layout diagram.
D. Select students to wire demonstration circuit and operate.

SUMMARY Review function, construction and circuitry of the S_2.

ASSIGNMENT

A. Students are to install circuit to specifications in their work stations for a grade.
B. Students are to complete diagrams in their notebooks using appropriate colors and numbering conductors in each cable run.

REFERENCES

A. Electrical Wiring, Residential, Ray C. Mullin
B. Electrical Wiring Fundamentals, Joseph H. Foley

KEY QUESTIONS

1. What is the letter symbol for a double-pole switch?
2. How is the symbol drawn for this switch?
3. Give some applications for double-pole switches?
4. Which circuit leg(s) does the switch break?
5. Why is an outdoor lighting installation using armored cable prohibited by the code?

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1981 Summer Curriculum Project

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1. Suggested additions, with reasons why you recommend them:

   _____

   _____

2. Suggested deletions, with reasons why you recommend them:

   _____

   _____

3. Methods and materials used sucessfully:

   _____

   _____

4. Reaction of teachers and students to this curriculum:

   _____

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